Concerning the Treatment of Intracranial Tumors in Infancy and Childhood

AUTHOR(S):

Bailey, Percival; Bucy, Paul C.; Tanaka, Kenji

CITATION:

Bailey, Percival ...[et al]. Concerning the Treatment of Intracranial Tumors in Infancy and Childhood. 日本外科宝函 1939, 16(3): 378-413

ISSUE DATE:

1939-05-01

URL:

http://hdl.handle.net/2433/205016

臨　　床

幼·小兒ニ於ケル腦腫瘍ノ治療ニ就テ

アメリカ，シカゴ大學神經學教室

バーシバル·ベイレイ　パウル·ビウシイ　及　田中憲二

和文內容抄錄

1928年7月31日ヨリ1933年1月4日ニ至ルシカゴ大學神經學教室ニ於テ手術並ニ組織學的檢索ヲ行ツタ16歲以下ノ幼小兒ノ腦腫瘍100例ニ就テ，成人ノ腦腫瘍ト種々ナル點ニ於テ異ナリ從ツテ其ノ外科的治療法ニモ自ラ異ルトコロアルヲ論ジタ。

	幼·小兒	成人
「グリオーマ」	76%	42.6%
「グリオブラストーマ·ムルチフオルメ」	7%	24.1%
腦下垂體腺腫	0%	17.8%
「ノイリノーマ」	1%	8.7%
「メニンジオーマ」	8%	13.4%

上記ノ如ク幼·小兒ニハ腦下垂體腺腫例ナク，「ノイリノーマ」，「メニンジオーマ」，「グリオブラストーマ·ムルチフオルメ」等ガ少ク，之ニ反シ「クラニオフアリンジオーマ」ガ大ナル率(5%)ヲ示セルコトハ注目ニ價スル。

「グリオーマ」76例中，天幕上部腫瘍16例，天幕下部腫瘍60例デアル。

診斷ハ大多數ノ症例ニ於テ神經學的檢査及ビX線單純撮影ニヨル。腦室撮影法ヲ施セルモノ19例，コレニヨリ診斷ヲ確實ニシ得タガ，腦水腫ヲ有スル小兒デハ異常高熱ヲ發シ死亡セル例等モ經驗セルガ故ニ注意ヲ要スベク，大多數ノ例ニ於テハ不必要ト思フ。

手術死亡率(75例中)　21.5%

症例死亡率　31.6%

ベイレイガ報告セシ如ク死亡率ニハ腫瘍ノ位置及ビ病理組織型ガ大ナル關係ヲ有スル。

大腦「アストロチトーマ」	12例中	1例死亡	5%
小腦「アストロチトーマ」	13例中	2例死亡	15.4%
第四腦室「エペンデイモーマ」			50%
「クラニオフアリンギオーマ」			0%（姑息的ニ囊腫內容ヲ除去シ，ソノ壁ノ一部ヲ除去セルノミ）

次ニ個々ノ腫瘍ノ代表的ノモノニ就テ述ブ。

1) **松果線腫瘍：第1例**；13歲半ノ少年。早熟ガ見ラレル。松果腺畸形腫ヲ腦底體切開ニヨリ2回ニワタリ摘出術ヲ行ツタガ第2回術後7日ニ死亡。吾々ハ成人ニ於テ本腫瘍ノ2例ノ治驗例ヲ經驗シ，荒木ガ報告シテ居ルガ，手術的對照トシテハ決シテ絕望的ノモノデハナイ。

2) **「クラニオフアリンジオーマ」：第2例**；16歲ノ少年，囊腫內容排除及ビ壁ヲ切除セルノミデ甚シク輕快。本腫瘍ノX線照射ノ效果ニハ疑問ヲ持ツ。限局性ノ如ク見エルガ組織學的ニ檢スルニ上皮細胞ガ神經組織中ニ直接包埋シ，シバシバ主腫瘍ヨリ可ナリ離レタル部分ニ，長イ上皮細胞突起ヲ出シテ居ルノヲ見ル(第1

圖)。從ツテ根治手術ヲ行ハウトスレバ，ウイリス循環ヲ傷ケ出血ヲ來シ，或ハ異常高熱，「コラップス」等ガ來ル。吾々ハ本腫瘍ハ姑息的療法ニヨルベキモノタルヲ强調シ，死亡率0%ナルヲ示ス。

3) **「メニンジオーマ」及「ノイリノーマ」**：幼・小兒デハ稀デアリ，多發シ易シ。單發性ノ「メニンジオーマ」ハ肉腫變性トナルコト多シ(第2圖)。手術ニヨリ根治シ得ベク，時ニ再發。**第3例**；13歲ノ少女ノ右前頭部「メニンジオーマ」ノ例ヲ述ブ。

4) 視神經交叉部，視丘下部，間腦，腦脚，延髓等ニ於テハ腫瘍型ノ如何ニ不拘，手術不可能。

a) **腦脚「グリオーム」**(第3圖)ハ延髓神經ノ多發性麻痺アリ，腦壓亢進ノ症狀ヲ伴ハズ，腦炎等ト誤マラレルコトアリ，小兒科ニ於テハ診斷的興味アリ。**第4例**；4歲ノ腦脚部「グリオブラストーマ・ムルチフオルメ」ノ例ニ就テ述ベタ。

b) **視神經交叉「グリオーム」**(第4圖)。ヤヽトモスレバ手術シ易イ傾向ガアル。腫瘍ハ視丘下部，視神經交叉，視神經ヲ犯シ第4圖ノ如ク摘出困難デアリ，單ナル開顱モ異常高熱ヲ發スル。手術ハ行ハズ，X線照射ヲヨシトス。**第5例**；13歲ノ少年，視神經交叉部，視丘下部ヲ犯セル「グリオーマ」ノ部分的切除ヲ行ヒ，後X線照射ヲ行ヒ，ヤヤ輕快シタガ時々惡化シ減壓療法ヲ行ツタ。

天幕膜上部「グリオーム」ニハ多言ヲ要シナイ。**後頭蓋窩ノ「グリオーマ」**：**「エペンデイモーマ」**(第5圖)ハ50%ノ死亡率デクツシング，フオード，ヴアンサン等ノ言フ如ク悲觀スベキモノ。手術ノ好對照トナル如クデアルガ實ハ限局性ナラズ且ツ術後延髓ノ二次的循環障碍ガオコル。故ニ減壓療法ヲ可トスル。**第6例**；13歲ノ少年，「エペンデイモーマ」ノ例，再發手術ヲ行ヒ死亡。

c) **小腦蟲樣體下部ノ腫瘍**ハ肉腫又ハ**「メヅロブラストーマ」**ヲ考ヘル。惡性ニシテ鑑別困難。サツクス，ペンフイールド等ノ治驗例ガアルガ疑問ナリ。クツシングハ26.3%ノ手術直接死亡率，吾々ガ單ニ試驗組織片摘出ノ目的ノミニ止メ完全摘出ヲ行ハヌモノノ死亡率15.4%，剖見ニヨリ軟腦膜ニマデ轉移アルモノアリ。

術後X線照射ハ效果アレドモ餘リ强力ナル時ハ神經組織ノ脂肪變性ヲ來ス。

小腦中央部ノ惡性腫瘍：i「メヅロブラストーマ」，ii 腦膜肉腫

第7例；「メヅロブラストーマ」，8歲ノ少女，術後1年1ケ月後，X線照射後突如死亡セルガ，コレハ疑ヒモ無ク蟲樣體ニ於ケル巨大腫瘍ノタメデアルガ，Cutler ノ言フ如ク術前ニ照射ヲ行ヘバ術前ニ死亡セルモノナルベシ(第6圖及第7圖)。**第8例**；11歲ノ少女，最初手術サレ「メヅロブラストーム」，X線照射ヲウケ效ナシ。3ケ月後死亡，肉腫變性セリ。

d) **「アストロチトーマ」**；外科的手術對照トシテ好個ノモノ，ヨク限局サレ(第8圖)，クツシングノ死亡率ハ11.2%，我々ノモノハ5%，術後長期間生存ス。**第9例**；12歲少女，右小腦半球ニ於ケル囊腫性「アストロチトーマ」(プロトプラズミック)，完全切除，8年間健在。**第10例**；10歲半少女，右小腦半球ニ於ケル囊腫性「アストロチトーマ」(フイブリラリイ)，患者ノ狀態惡化シ，主腫瘍ノ摘出ヲ行ハズ，姑息的ニ囊腫壁ノ一部切除ノミデ8年間健存。**第11例**；8歲ノ少女，右小腦半球「アストロチトーマ」(プロトプラズミック)，囊腫壁ハ正中線ヲ越エテ反對側ニモイタリ，大部分ヲ切除シ，3年後再發，巨大ナル腫瘍(111瓦)ヲ完全摘出。

結辭：腦腫瘍殊ニ幼，少年ニ於ケルモノノ治療ニ對スル合理的ナ方向ヲ定ムルニハ病理學ガ重要性ヲ占メルモノデアリ，サツクス或ハダンデイノ如ク病理ヲモ患者ノ豫後ヲモ省ミズ「メス」ヲフルフ態度ニハ贊成ハ出來ナイ。吾々ハソノ臨床症狀ヨリ術前腫瘍ノ病理學的診斷ガ豫想シ得ラレル「クラニオファリンギオーマ」又ハ腦幹ノ「グリオーム」ノ場合ニハ根治手術ハ行ハナイ。「メヅロブラストーマ」ト「アストロチトーマ」トノ鑑別ニハ開頭ヲ行ヒ試驗切片ヲ取ツテ診斷ヲ確實ニシテ手術ヲトヾメ又ハ進行サセル。カツトラー等ノ言フガ如ク術前X線照射ニ對シ敏感デ輕快スルモノハ「メヅロブラストーマ」ト診斷シ手術ヲ行ハヌト報告シテヰルガ，吾々ハX線照射後マモナク死亡セル例モ經驗シテ居ルノデ，直チニ贊意ヲ表シ難イガ，正シイ方向ニ進メル意見ト考ヘル。

腦腫瘍ノ病理學，症候學等ハ既ニ衆知ノコトデアリ，外科的技術モ進歩シテ居ルガ，殘ル問題ハ術前ニ手術スベキモノトスベカラザルモノトヲ區別スルコト，卽チ手術ノ適應ヲ決定スルコトガ重要デアリ，將來コノ方面ニ檢索ガ向ケラレナケレバナラヌ。

Concerning the Treatment of Intracranial Tumors in Infancy and Childhood*

Percival Bailey, Paul C. Bucy and Kenji Tanaka

Experience with intracranial tumors as they affect infants and children has taught us that they differ much from those of adults. It is true that this fact has been before remarked (Cushing, 12) but when we attempted to gain more definite and detailed information concerning the nature of these differences the discussions seemed to us to lack precision (Cushing, 12), to be mere summaries of similar discussions concerning tumors of adults (Camp, 9) or to contradict our own experience (Critchley, 10).

Moreover the general pessimism among pediatricians concerning the results of surgical treatment of such neoplasms caused us to wish to review our own experience in this difficult field. This pessimism was remarked by Cushing (12) in his address before the New England Pediatric Society as follows: "Gentlemen, I was the more ready to accept Dr. Sisson's invitation to address you because of a letter recently received from a distinguished neurologist in a distant city. Relative to a chapter on nervous diseases he is preparing for a general textbook of pediatrics he wrote to ask if we had ever seen any recoveries after removal of tumors of the brain in children, adding that in his personal experience the operations were either fatal or gave bad results." A perusal of the chapter on intracranial tumors in Ford's (22) recent textbook on diseases of the nervous system in infancy, childhood and adolescence, although the operations were performed by as eminent a surgeon as Dandy, is scarcely more encouraging.

We chose, as the basis of our study, a series of 100 consecutive cases of histologically verified and classified intracranial tumors. These occurred in this clinic between July 31, 1928, and January 4, 1938. All children who were admitted to the service before reaching their 16th birthday have been included, if we were able to verify their tumors histologically. After careful consideration of the unverified cases we do not believe that their verification would materially have altered our conclusions. We have no intentions here to discuss all the data concerning the entire series of 100 tumors. This will be done in a monograph to be issued soon (Bailey, Buchanan and Bucy, University of Chicago Press, 1939). We wish here to discuss only the problems of surgical treatment with a few illustrative cases.

---

* From the Division of Neurology and Neurosurgery, University of Chicago Clinics. Aided by a grant from Child Neurology Research (Friedsam Foundation).

PATHOLOGICAL CLASSIFICATION

A. Neuroepithelial				76
1. Gliomas			75	
a. Astrocytomas		30		
Fibrillary	12			
Protoplasmic	13			
Small-celled	2			
Gemistocytic	2			
Pilocytic	1			
b. Medulloblastomas		13		
c. Ependymoblastomas		7		
d. Spongioblastomas		10		
Primitive	4			
Polare	6			
e. Glioblastoma multiforme		7		
f. Astroblastoma		2		
g. Oligodendroglioma		1		
h. Medulloepithelioma		1		
i. Mixed		2		
j. Atypical		2		
2. Papilloma chorioideum			1	
B. Mesodermal				16
1. Meningiomas			8	
a. Fibroblastic		2		
b. Fibrosarcomatous		2		
c. Mesenchymal		2		
d. Meningothelial		2		
2. Sarcomas			7	
a. Alveolar		6		
b. Perithelial		1		
3. Neurinomas			1	
C. Pituitary Tumors				5
1. Craniopharyngiomas			5	
D. Pinealtumors				5
1. Pinealomas			3	
a. Differentiated		1		
b. Undifferentiated		2		
2. Teratoid			2	
Total Tumors				102
Duplicates				2
Total Cases				100

This is not far off from Ford's (22) estimate that 75 percent of all intracranial tumors of childhood are gliomas, of which about 9 percent are glioblastoma multiforme and that, of the remaining 25 percent, 13 percent are hypophysial duct tumors and 4 percent pineal tumors. We are sure that our percentage of craniopharyngiomas should be higher than the 5 percent of our statistics since we turned away some patients who we were sure had such tumors but considered inoperable.

We may note the virtual absence of neurinomas (1 percent), the rarity of meningiomas (8 percent), the total absence of pituitary adenomas, and the low incidence of glioblastoma multiforme (7 percent) as the outstanding differences from the conditions in adult life, as given by Cushing (13) :

			Number	Percent
I. Gliomas (varia)			862	42.6
A. Unclassified		175		
B. Classified		687		
Astrocytoma	255			
Glioblastoma multiforme	208			
Medulloblastoma	86			
Astroblastoma	35			
Spongioblastoma polare	32			
Oligodendroglioma	27			
Ependymoma	25			
Pinealoma	14			
Ganglioneuroma	3			
Neuroepithelioma	2			
II. Pituitary adenomas			360	17.8
Chromophobe		264		
Chromophile		73		
Mixed		23		
III. Meningiomas			271	13.4
IV. Acoustic neurinomas			176	8.7
V. Congenital tomours			113	5.6
Craniopharyngiomas		92		
Cholesteatomas and dermoids		15		
Chordomas and teratomas		6		
VI. Metastatic and invasive tumours			85	4.2
VII. Granulomatous tumours			45	2.2
Tuberculomas		33		
Syphilomas		12		
VIII. Bloodvessel tumours			41	2.0
IX. Sarcomas (primary)			14	0.7
X. Papillomas (choroid plexuses)			12	0.6
XI. Miscellaneous			44	2.2
			2023	100.0

Our table shows clearly the great preponderance in childhood of neuroepithelial tumors (76 percent) over mesodermal tumors (16 percent), with only 5 percent each of pineal and pituitary tumors.

By location the tumors were distributed as follows:

Location of All Tumors

Supratentorial	34
Infratentorial	69
	103
Duplicates	3
Total	100

Location of Neuroepithelial Tumors

Supratentorial	16
Infratentorial	60
Total	76

Location of Neuroepithelial Tumors

Cerebellum	39
Pons	12
IV ventricle	7
Hypothalamus	6
Cerebral hemispheres	5
Optic chiasm	4
Cerebral peduncles	1
Thalami	1
Bulb	1
Total	76

Location of Mesodermal Tumors

Cerebellar	6
Frontal	4
Temporal	2
Occipital	1
Central	1
XII nerve	1
Multiple	1
Total	16

The overwhelming predominance of neuroepithelial tumors in the subtentorial region is in marked contrast to their distribution in adults. The predominance of subtentorial tumors in general is also evident and in accord with the findings of Cushing (12), Critchley (11) and others.

The great majority of these tumors were correctly localized from the symptoms and neurological examinations aided by ordinary roentgen photographs of the head. But in 19 instances ventriculograms were made; in 10 cases to demonstrate a tumor whose situation was uncertain, in 7 to localize more accurately a tumor whose general situation was known, and in 2 cases as an aid in planning a surgical attack. We did not use this method more often because it was unnecessary and also because we have found it dangerous in these children with large hydrocephalic heads; they easily devel p a hyperthermia. One of our cases died of hyperthermia following a ventriculogram. Doubtless many die really from ventriculography but it is difficult to prove how great a role this procedure plays in the mortality rate of those clinics in which ventriculography immediately precedes operation.

In general our results with the treatment of these tumors may be stated as follows:

In 79 an attempt was made to remove a tumor.

In 21 an extirpation was not attempted since

in 8 death occurred before surgical consultati n,

in 8 death occurred after ventricular puncture in extremis, and

in 5 cases the lesion was considered inoperable.

In 17 cases the first operation hastened death, an operative mortality of 21.5 percent.

In 8 cases a secondary operation resulted in death, making a case mortality of 31.6 percent.

Of the 17 primary fatalities 5 could have been prevented by proper postoperative care and 4 patients should never have been operated upon but should have been recognized clinically as inoperable. If these latter 4 cases had not been operated on there would have been 75 operations with 12 fatalities or 16.0 percent. Avoiding the 5 preventable fatalities, of which 3 resulted from delay in making a transfusion of blood, and 2 from aspiration of vomitus, the mortality would have been 9.3 percent, a reasonable figure. We believe it possible, with the best clinical judgment and operating under ideal conditions, readily to lower the mortality to between 10 and 15 percent. But it should not be forgotten that this demands judgment at the operating table as well, and a desire not to increase the operative mortality unduly. If an attempt is made to remove radically every tumor disclosed at operation the mortality rate will be much higher even than the one we have just reported.

But, as Bailey (3) has previously insisted, such a global mortality rate means little. The mortality rate is greatly influenced by the location of the tumor regardless of its nature; and by the pathological type as well. Twenty operations were performed for astrocytoma cerebelli with one fatality—a rate of 5.0 percent; while for medulloblastoma cerebelli 13 operations were made with two deaths—a rate of 15.4 percent, although the situation of these tumors is the same; and for the ependymomas in the fourth ventricle the mortality was 50 percent. In all three of the foregoing cases the operative approach was the same and the situation of the tumors very similar. Another very important factor in the mortality rate is the extent to which the operation is pushed. We have never lost a craniopharyngioma at primary operation—the mortality rate is 0—which would be a truly remarkable performance until one remembers that we content ourselves with evacuation of the cyst and partial removal of its wall; if we had attempted to extirpate these same tumors completely the mortality rate would have been in the neighborhood of 100 percent.

The imposing lists of figures which one finds in the literature mean little and cannot be interpreted unless one has at hand the data from which they were compiled. Statistics are valid only for the factors common to the data underlying them after the variable factors have been shown to be irrelevant. In the compilation of most statistics concerning brain tumors such factors as location of the tumors, pathological type, extent and completeness of removal, subsequent condition of the patient, etc. do not appear and these factors are by no means negligible. Exceptions are the studies of Cairns (8), van Wagenen (34) and Eisenhardt (18).

We may begin the detailed discussion of our material with the pineal tumors, since their location is practically uniform and more important usually than the pathological type. The one serious attempt which we made to remove such a tumor failed and the patient died.

Case 1. G. S., a boy of 13½ years, was admitted to the University of Chicago Clinics on the 16th of January, 1932 (Unit No. 53222). He was referred by Dr. O. C. Erickson of Sioux Falls, South Dakota.

History. The boy was born normally, on the 31st of August, 1918. He was breast-fed and developed normally. He had mild attacks of measles, whooping cough and scarlet fever in childhood but he was always considered a normal child, although slender and frail, until September, 1931. Then he began to grow rapidly, develop a voracious appetite, and his genitalia increased markedly in size. He developed abundant hair over the body and his voice became of adult masculine pitch. In October he began to complain of seeing double. In November he began to have spells of sharp pain in the frontal region accompanied by vomiting, cyanosis and perspiration. He complained also of ringing noises in the ears. During the last two months he became drowsy, had more and more headache and remained in bed because of dizziness when he stood erect.

Examination. On admission the boy was somnolent but he was easily aroused and then was co-operative. He was 149 cm. in height and weighed 37.5 kg. His blood pressure was 110/70 and the pulse rate around 60. There was no cracked-pot sound when the skull was percussed. The optic discs were swollen 2–3 diopters, the visual fields were normal. Vision was reduced to 0.4 in the right eye and 0.3 in the left. Both pupils were dilated, the left more than the right, and they both reacted sluggishly and slightly to light. There was a slight bilateral ptosis and slight weakness of the right external rectus muscle. The range of upward movement in the eyes was very limited both on voluntary effort and in Bell's maneuver. Convergence was also limited in both eyes. The audiometer demonstrated only slight impairment of hearing to high tones. The deep reflexes were normal, there was no clonus and both plantar responses were flexor in type. The tone of the muscles was normal and there was no weakness. Slight tremor of the hands was evident but there was no incoordination. Sensation was normal over the face and body. The basal metabolic rate was -26 percent and the output of urine was about 550 cc. per day. X-ray photographs of the head revealed a dense mass of calcification 0.5 cm. in diameter lying forward, downward and to the left of the normal position of the pineal body. The sella turcica appeared normal. The optic foramina were not enlarged and the cranial sutures were not dilated.

The diagnosis was obviously that of a tumor in the neighborhood of the pineal body. The early appearance of puberty suggested a tumor of the pineal body itself, there being no good reason to suspect a tumor in the third ventricle, but the displaced calcification looked as though the pineal body might be normal. Thinking that we might want to approach the tumor through a lateral ventricle, a ventriculogram was made on the 21st of January 1932. The lateral ventricles and the anterior portion of the third ventricle were not found to be unduly dilated. The posterior portion of the third ventricle was occupied by a mass which extended also into the body of the right lateral ventricle.

Because the tumor appeared on the ventriculogram to be very large deep X-ray therapy was attempted, but because of his condition only 157 r. units were given, on the 25th of January. After this he grew definitely and rapidly worse and the lateral ventricles had to be punctured repeatedly.

Operation. On the 28th of January, 1932 a right subtemporal decompression was made by Dr. Bailey in the hope that the tumor might shift farther to the right and so remove pressure on the aqueduct. But the boy became stuporous and repeated punctures of the lateral ventricles were needed. So on February 2, 1932, a transcallosal approach was made, by Dr. Bailey, under ether anesthesia. A bone flap was turned down in the right occipito-parietal region and, after the thin splenium was divided, the smooth reddish-gray surface of the tumor was exposed. It was impossible to get around the tumor because of its size and it was too tough to remove with a suction apparatus or curette. So it was necessary to use an electric loop, cautiously, until as much as could be readily exposed was removed.

Finally a large vein was opened which could be stopped only by implantation of muscle, and the operation was abandoned.

Surgical specimen. The specimen consisted predominantly of fibrous connective tissue but there were a few small cysts lined with epithelial cells and filled with coagulum. It was thought to be a *teratoid tumor* of the pineal body.

Subsequent course. The condition of the patient was excellent at the end of the operation, but he did not improve. He remained stuporous and it was necessary repeatedly to puncture the ventricles.

Second operation. On February 18, 1932 another attempt to remove the tumor was made by Dr. Bailey. A bone flap was turned down in the left parietal region, the falx cerebri divided from just internal to the superior longitudinal sinus to its inferior margin, and the region more adequately exposed, this time under local infiltration with novocaine. Again it was found impossible to get around the tumor so again it was attacked by the electric loop and the median portion apparently completely removed. The vena Galeni could be seen, entering the sinus rectus. The internal occipital vein on the left side could be seen entering the basilar vein. The basilar vein on the right side had been injured by the electric loop at the previous operation. Hoping that we had removed the obstruction to the aqueduct the operation was terminated. The condition of the patient remained good. His blood pressure was 120/80 at the close of the procedure.

Subsequent course. On the 19th of February he lay stuporous with slow movements of his eyes from side to side. There was a bilateral Babinski sign and typical Magnus-de Kleijn tonic cervical reflexes. Both pupils were contracted and did not react to light. The decompression was tense. The ventricles were repeatedly punctured and the patient fed by nasal tube. On February 22nd, he lay quietly and occasionally blinked his eyes. The eyes rolled slowly to the left and were repeatedly moved quickly back to the midline. Occasionally there was a convergent spasm of the eyes. The pupils were contracted and did not react to light. All the limbs were flaccid but there was a bilateral Babinski sign. The jaws were tightly clenched. His temperature, which had been as high as 40.5°C., was on this day between 38° and 39°C. On February 23, his temperature rose again to 41°C. He lay quietly apparently in no discomfort. His eyes were open and occasionally winked. From time to time the eyes would roll slowly to the left with repeated convergent spasms in which the eyeballs were also retracted. The pupils were small and did not react to light. The decompression was soft. The left arm was sometimes moved slightly, never the right. Typical tonic cervical reflexes were obtained in the arms; the legs were not much affected. Flexion of the neck caused flexion of both upper extremities across the chest. His condition changed little until his death on February 25.

Autopsy. A postmortem examination was made one hour and fifteen minutes after death by Dr. Bailey. It was restricted to the head and at the insistence of the father, who was present, the brain was not removed. The two parietal bone flaps were reflected and the lateral ventricles opened. Because of the marked hydrocephalus an excellent view of the situation of the tumor was obtained. It lay above the midbrain and diagonally, extending anteriorly into the right lateral ventricle and downward through the incisura tentorii into the left cerebellopontine angle. The roof of the midbrain was compressed to the thinness of a sheet of paper. The aqueduct was dilated and flattened transversely and was occluded only by compression. The vermis of the cerebellum was deeply indented by the posterior margin of the tumor, which measured $6 \times 3 \times 3.5$ cm. It had a grossly nodular but smooth surface, on which could be seen numerous small cysts. In the middle region of its upper surface

was a ragged cavity 3 cm. in diameter made at operation. There was very little blood clot in this region. The inferior longitudinal sinus was divided and a silver clip securely on each end. The medial surfaces of the parietal lobes were slightly contused, especially just above the splenium of the corpus callosum, which was thinned to about 1 mm. in thickness and had been transected for a distance of 3 cm. anterior to the splenium.

The tumor was composed of an intimate mixture of mesodermal and ectodermal tissues. The ectodermal tissue was differentiated in many different ways. There were areas of small, oval, densely-stained nuclei closely packed together without any architectural arrangement; these areas resembled the embryonic pineal body. Other areas had the mixture of large cells with vesicular nuclei and small lymphocytic cells characteristic of pinealomas. In still other areas was squamous epithelium, often cornified. Cysts lined with columnar ciliated epithelium were numerous, filled with an amorphous precipitate. Finally cavities resembling embryonic neural canals were found. The mesodermal tissue was mostly loose areolar tissue, but denser collagenic areas were present and even well-developed cartilage. No mucoid cells of entodermal type were found. There were areas of ectodermal cells containing melanin.

The tumor was a *teratoid* tumor of the pineal primordium.

COMMENT

This is the only case in our series with precocious puberty associated with a pineal tumor. As is the rule the patient was a boy. Two others of our cases showed signs of early puberty, one was a hypothalamic glioma, the other was a craniopharyngioma.

The lateral ventricles were not sufficiently enlarged to make an approach through the lateral ventricle practicable. Perhaps we might have done better by removal of one occipital lobe but the size and unusual situation of the tumor would in any case have made removal very difficult.

When we read over the record of the surgeon with the greatest experience in the treatment of these tumors (Dandy, 16) and the combined experience of all surgeons as recorded in the literature (Araki, 1) we do not feel much chagrin at our failure. Cushing (13) says frankly that he "never succeeded in exposing a pineal tumour sufficiently well to justify an attempt to remove it". Others have occasionally succeeded (Dandy, Cairns, van Wagenen, Horrax, Foerster) in making more or less complete removals. But a study of the postoperative condition of these patients is needed. Our own experience with other tumors in this locality is not encouraging (Araki, 2). Many of them have subsequently been reported as recovering and dying following secondary operations [Horrax, Dandy (Case 1)]. Often metastases occur from pinealomas which must make extirpation impossible.

The *craniopharyngioma* of which the following case is a typical example is also a very unsatisfactory tumor to deal with surgically.

Case 2. On the 24th of August, 1936. D. C., a boy nearly sixteen years of age, was admitted to the University of Chicago Clinics (No. 158535). He was referred by Dr. J. L. Garvey of Milwaukee.

History. This boy was born normally and had no serious illness in childhood. It had been evident to his parents that in the past four years he had been much overweight. In the summer of 1935, he weighed 203 pounds. However, he was quite active and did well in school until the spring of

1936. Then he found his studies to be very difficult for him and he voluntarily left school and refused to go back. At this time he began to do foolish and pointless things which he could not explain and he became constantly sleepy. Headaches began about May, 1936, and from then were almost constantly present. He had no vomiting and no defect in vision but for three months before admission he had unsteadiness in walking and ataxia of his hands.

Examination. He was an obese boy, weighing 180 lbs., whose blood pressure was 108/84, pulse rate 68 per minute and basal metabolic rate -30 percent. He had a female distribution of fat with mammary development and very scanty hair on his body. His testicles and penis were small but he had some pubic hair. He said that erections and nocturnal seminal emission had been present for a year. Frequent urination and frequent drinking had been noticed by his parents for six months and occasionally he had incontinence of urine. His intake of fluid was around 1200 cc. and the output of urine 850 cc. daily. He was extremely sleepy and had to be continuously aroused during the examination. He seemed normally cooperative when he was kept awake and normally intelligent but he laughed foolishly and often gave childishly foolish answers.

Both optic discs were elevated 3 diopters and he could read newsprint at 2 feet with his right eye but could not read with his left. He showed no defect in the external conjugate movement of his eyes and had no nystagmus but he was able to converge. The visual fields were normal. There was marked hypotonia of all his limbs with pendular knee jerks and rebound phenomena in his arms. His deep reflexes were not increased and his plantar responses were both flexor. He had very slight ataxia in the action of his hands and a definite dysarthria. When he walked, his feet were not widely separated but he was very limp and loose. X-ray photographs of his skull showed no separation of the sutures but there was an irregular mass of calcification within and above the sella turcica. The sella turcica was enlarged, the anterior clinoid processes undermined and the dorsum sellae completely eroded.

Operation. Dr. Bucy, on the 29th of August, 1936, explored the region of the sella turcica, through a right transfrontal approach. The right frontal lobe was raised from the orbital plate extradurally and the dura mater incised in front of the sphenoidal region. Several small masses of yellowish tissue were seen lying beneath the right optic nerve. A needle was inserted into the sella turcica but no fluid could be aspirated from there. The needle was then inserted through the lamina terminalis between the chiasm and the anterior communicating artery and 25 cc. of orange-colored fluid containing cholesterol crystals was aspirated without difficulty. A small piece of the cyst wall, and a portion of the tumor mass under the right optic nerve were then removed. A drain was placed between the dura mater and the bone and the wound closed.

Surgical specimen. The tissue removed consisted of gliosis in which were embedded islands of stratified squamous epithelium, sometimes calcified. The structure of the tissue was compatible with a diagnosis of *craniopharyngioma*. The wall of the cyst was composed of several layers of stratified squamous epithelium which seemed to rest directly on the underlying neuroglia but that this was not true was readily proved by a Perdrau preparation which disclosed a connective tissue capsule everywhere between the epithelium and the neuroglia.

Subsequent course. The boy withstood the operation very well, the drain was removed on the third day, and the oedema of the eyelids had entirely gone by the end of a week. Twelve days after the operation X-ray therapy was started and he was given 2709 r-units to the skull in nine doses over three portals. He was seen two months later and then was bright and intelligent. His weight was only

166 lbs. He had no polyuria or polydypsia and his visual acuity were normal. On the 21st of January, 1937, he weighed 154 lbs. and his basal metabolic rate was −29 percent. On May 16, 1938 he was well, going to school and obtaining good grades. The vision was normal in both eyes.

COMMENT

In this case the evidences of hypothalamic involvement (obesity, somnolence, polyuria, genital underdevelopment) were so outstanding that the cerebellar signs (ataxia, dysarthria, hypotonia) would have been discounted even though the calcification visible in the roentgenogram had not established the localisation. The improvement obtained after operation was very remarkable but the excision being only fragmentary recurrence of the symptoms is to be expected.

Because of experiences in other cases we doubt that the roentgen therapy played any part in his rapid improvement. It is generally accepted that such radiation is ineffective for these tumors although Frazier seems to have been more favorably impressed by his experience.

The craniopharyngiomas are fairly uniform in type and location. Here the all important factor is the extent of the extirpation. We have already noted that our own mortality is zero. The mortality rate depends largely on the accuracy of the surgeon's instinct that it is time to stop. Cushing (13) usually was content with evacuating the cyst and removing a fragment of its wall; but occasionally he became more temerous, the result being a mortality-rate of 13.6 percent. Others give other figures; they all mean little. Many of the patients die immediately with a hyperthermia. The severe acute postoperative symptoms are doubtless due to collapse, edema and trauma to the hypothalamic nuclei. These may follow simple evacuation of a large cyst. Moreover toxic postoperative complications (urticaria, itching, flushing, sweating and blistering of skin) may occur which have been attributed by Critchley and Ironsides (11) to the evacuation of cholesterin into the spinal fluid. After the acute complications are past various symptoms remain, the most common being diabetes insipidus and the hypopituitary syndrome. The hypopituitary symptoms are often present before operation but any radical extirpation must risk making them much worse by removal of the remnants of hypophysis. And we have still no adequate treatment for hypophysial deficiency. But if the cyst is only evacuated or incompletely removed the symptoms recur, usually in a short time. We must admit that surgical treatment of this tumor is very inadequate.

Others are of the same opinion. "On objectera sans doute que de tels résultats pour des études cliniques aussi complexes et des opérations aussi dangereuses sont maigres (Vincent, David and Puech)". "But all in all, these cases offer the most baffling problem which confronts the neurosurgeon; and the fact that the mortality which accompanies radical attempts to extirpate a large solidified tumour must approximate 100 percent probably accounts for the few reports of these lesions other than by pathologists. Even from the mere standpoint of preservation of vision the problem is a highly complicated and difficult one (Cushing)". "The outlook as to expectation of life in the majority of such cases is gloomy (Frazier and Alpers)".

There remains only the restraining influence of roentgen radiation, generally held to be ineffective, although Frazier in his later years (23) was more hopeful.

The reasons for the surgeon's disappointments are apparent to the pathologists. This tumor which seems so circumscribed nevertheless adheres rather firmly to many structures nearby. It seems often to have a capsule of connective tissue but there are always areas in which the epithelial cells are embedded directly in the nervous tissue (McLean, 26). Often long fingerlike processes of epithelial cells project to a considerable distance from the surface of the main mass (Fig. 1). The result is that an attempt to pull such a tumor away from its bed may bring along the flattened remains of the hypothalamus, with a resultant diabetes insipidus. The bloodvessels of the circle of Willis are often firmly adherent to the surface of the tumor or even embedded in it so that any attempt to free them may result in severe hemorrhage. Since the tumor extends often as far back as the pons it is evident that a hemorrhage from the basilar artery, so far from the operative incision, might be impossible to check, and that even if the artery were successfully occluded, the result would be very serious for the patient. Moreover, although those which arise from the upper anlage above the diaphragma sellae may only compress the hypophysis, those which arise from the lower anlage below the diaphragm are intimately attached to the hypophysis which can be recognized only microscopically. Any attempt to remove these tumors must result in a total ablation of the hypophysis with a severe hypopituitary syndrome. And even those above the diaphragm have the inconvenience that they lie behind the optic chiasm which, because of the short optic nerves, cannot be retracted out of the way of the operator. So that, even though the tumors are often cystic and permit reduction of the size of the growth readily by evacuation of the contents, they remain the despair of the neurosurgeons, who have found that simple evacuation of the cyst or partial removal are unsatisfactory and complete removal impossible or so disabling as to be inadvisable. The difficulties have been very graphically described by Vincent et al (32). And Frazier and Alpers (24) write: "There is a thick-walled well-defined capsule which gives the tumor a false appearance of being benign, but though they are encapsulated these tumors are so intimately related to the structures at the base of the brain that they cannot be removed without grave injury. At some point or other they seem to become a part of the brain and they are therefore probably malignant tumours in this sense".

The tumors of the coverings of the brain—*meningiomas and neurinomas*—are unfortunately rare in infancy and childhood and tend to be multiple (Turner and Gardner, 31), Bailey and Herrmann, 6). The single meningeal tumors also tend to be sarcomatous, invade the brain tissue and reach enormous size usually before giving symptoms (Fig. 2) (Ley 25). These tend to recur even after apparently successful removal (Ford, 22, case p. 708). But occasionally a meningotheliomatous type will be encountered which can be permanently removed. We were able to accomplish this in three of our cases. The following case is an example of a meningotheliomatous tumor of the type usually seen in adults occurring in a girl thirteen years of age.

Case 3. On the 26th of March, 1934, A. C., a thirteen year old girl, came to the University of Chicago Clinics (No. 101186). She was referred by Dr. D. S. Harvey of Chicago.

History. She was born on March 30, 1921 as the first of twins who were not identical. The delivery was at full term and without complication apart from an injury to the left leg. Her early development was normal. When two and a half years old, she received a blow on the head in the right parietal region and the scar produced at that time was painful until it was excised in 1933. Her first convulsion occurred in September, 1933, and she was able to describe its sequence. There was first a frontal headache, then blinking of the eyes, a closing of the left eye, a drawing feeling on the left side of the neck, movement of the left hand and left arm and then complete unconsciousness. She had about twenty of these convulsions and all of them had followed the same Jacksonian march.

Examination. No organic signs of any kind were found but she was admitted to the hospital for encephalography because of the focal character of the attacks. On the 29th of March, 1934, encephalography was done but, although 74 cc. of fluid were removed and a similar amount of air injected, there was not enough air present in the ventricles to make a diagnosis.

A ventriculogram was made three days later and seemed to show that the body of the right lateral ventricle was displaced downward slightly. It was decided not to explore the right parietal region until some definite organic neurological sign appeared.

Re-admission examination. The girl was very cooperative and had no complaints. She had papilloedema in both eyes of 2 diopters without any evidence of atrophy. There was a partial bilateral ptosis and a slight left-sided weakness of the movements of the face. The eye movements were full and synchronous in all directions and there was no nystagmus. The visual fields were full. The left knee jerk was increased and the left plantar response was extensor. The power of the left hand was less than that of the opposite limbs and pin prick was not appreciated as well on the left leg as on the right. There were no other neurological signs.

It was thought that she had a right-sided central tumor and to confirm this diagnosis, an encephalogram was made which showed definite evidence of a neoplasm lying in that location.

Operation. On the 7th of December, 1935, Dr. Bucy explored the right posterior frontal region under avertin and ether anesthesia. The bone in the center of the osteoplastic flap was unusually vascular, and when the dura mater was incised a yellowish meningioma was exposed. It extended to within 2 cm. lateral to the superior longitudinal sinus, lay approximately over area 6 and was attached to the dura mater but had not invaded the bone. It was removed from the brain substance without difficulty and was found to weigh 77.5 grams. The bone flap was replaced without leaving a decompression.

Surgical specimen. The tumor was composed of streams and whorls of elongated cells with dense cytoplasm, and of elongated nuclei with delicate chromatin and irregular membranes. Between the cells there was sometimes a network of reticulin but in most areas the neoplastic cells formed a sheet of cytoplasm without reticular network. A few small spots of calcification were present. The tumor was firmly attached along one side to the dura mater. The tumor was a typical *meningioma*, of meningotheliomatous type.

Subsequent course. She had very little reaction from the operation and was able to walk and to leave the hospital nine days later. Phenobarbital was prescribed but not regularly taken in the subsequent two years and she had, in that period, between 20 and 30 attacks. In these she had twitching

of the left side of the face and blinking of the left eyelid but no loss of consciousness. She became coarser in her appearance, in her manners and in her speech since the operation, but there was no definite evidence, two years later, of any recurrence of the tumor.

She returned to the hospital January 18, 1938 because of behavior difficulties. She was boastful, rude and arrogant. Her I. Q. was 82. She was unmanageable at home and promiscuous in her sexual contacts. The only other sign of an organic neurological disorder was some slight general sensory loss on the left side of the body and the fact that the tendon reflexes were brisker in the left arm and leg. An encephalogram was made on January 29, 1938 which showed a slight dilatation of the right lateral cerebral ventricle and slight displacement of the ventricular system to the right.

COMMENT

Careful scrutiny of the encephalogram made on March 29, 1934 and the ventriculogram of April 2 does not disclose any evidence of displacement or distortion of the ventricles. The tumor lay lateral and below the leg area of the central cortex and this situation was reflected in the character of the epileptic attacks.

It is not clear whether the behavior disorder which has developed since the operation is the result of the injury to the frontal lobe produced by the tumor and its removal, or to some totally unrelated cause.

Of the neuroepithelial tumors those of the optic chiasm, hypothalamus, midbrain, pons and bulb are inoperoble regardless of the type. The *pontine gliomas* (Fig. 3) are most interesting from a diagnostic standpoint. They are almost always misinterpreted in the pediatric clinic because there are no symptoms of intracranial hypertension. A diagnosis of encephalitis is usually made but, as one of us has pointed out elsewhere, encephalitis with predominant localization in the pontine region is almost unknown except after diphtheria. In our experience every time a child has developed multiple palsies of the bulbar nerves, without increased intracranial tension, necropsy has proved the cause to be a diffuse glioma of the brainstem. These tumors are not infrequent; our experience leads us to believe that they constitute at least 15 percent of intracranial neoplasms in childhood.

Case 4. B. O., a girl of four years, was admitted to the University of Chicago Clinics on the 1st of June, 1931 (Unit No. 38264). She was referred by Dr. K. Kato of Chicago.

History. She was born normally on the 10th of June, 1927, and developed normally. She had never any contagious disease. Her mother related that for some time the child had severe spells of coughing followed by vomiting. She had also become irritable and drooled saliva. About the 12th of May the mother noticed that the child's left leg seemed weak and she often fell. Nothing of significance was found in the previous history; there was no hereditary complaint in the family. On the 22nd of May the child was found to have a left hemiparesis and bilateral extensor plantar reflexes.

Examination. When admitted she was emaciated, irritable and resisted examination. There was a left spastic hemiparesis with clonus at the ankle and positive Babinski sign. The gait was hemiplegic and unsteady, the child falling to the left and backwards. The left eyelid drooped. The pupils were equal and reacted well to light and accommodation. There seemed to be paralysis of conjugate move-

ments of the eyes to the right side. There was no nystagmus. The optic discs were normal. The face was rather expressionless. The child drooled saliva and coughed when fed. She resisted obstinately any attempt to examine the throat. Sensation to pin-prick seemed to be normal everywhere. Temperature, respiratory rate, blood pressure and pulse rate were normal. Roentgenograms of the head disclosed nothing abnormal. No lead was found in the urine. The spinal fluid was under no abnormal pressure and contained 12 cells per cc. The child was discharged on the 16th of June, 1931.

Subsequent history. She was later admitted to the pediatric service of the Cook County Hospital on July 14, 1931, where there was found a left spastic hemiplegia, right peripheral facial paresis, right abducens paresis and ptosis of the left upper eyelid. A lumbar puncture disclosed 20 cells per cu. mm. and the spinal fluid to be under normal pressure. She became stuporous and died on the 30th of July, 1931.

Autopsy. An examination was made by Dr. Richard Jaffé to whom we are indebted for permission to examine the brain. He found, in addition to a pontine tumor, bronchopneumonia of the right lung and left lower pulmonary lobe, fatty degeneration and parenchymatous degeneration of the myocardium and kidneys.

The convolutions of the brain were slightly flattened. The pontine region of the brainstem was greatly distended by a tumor which had extended mainly into the right cerebellopontine angle but had infiltrated also the leptomeninx over the base, completely covering the basilar artery. The left side of the pons was also irregularly distended but the leptomeninges in this region were free. The entire specimen was mounted for the museum, after a segment had been removed from the upper surface for microscopical study. It was impossible therefore to study the internal relations of the neoplasm but it extended obviously from the cerebral peduncles to the inferior olives.

Microscopically the tumor proved to be very cellular. The nuclei were oval and definitely of glial type. Multinucleated cells were rare and mitoses difficult to find. The tumor was very vascular. The blood vessels had hypertrophied walls. There were numerous necrotic zones, giving rise to pseudopalisades. The cytoplasm of the neoplastic cells was scanty and delicate, with indistinct processes and no definite polarization. The margin of the tumor was not sharp and the surrounding tissue was irregularly infiltrated. The tumor was judged to be a *glioblastoma multiforme* of rather low malignancy.

COMMENT

Because of the absence of intracranial hypertension and the increase of cells in the spinal fluid this case was thought to be of infectious origin. This error is frequently made (Bailey, 3). This child was discharged from the pediatric service with a diagnosis of postinfectious hemiplegia. No opinion was ventured as to the nature of the infection. At the Cook County Hospital the neurologist diagnosed disseminated encephalomyelitis with main localization in the pons (hemiplegia alternans inferior).

There is a tendency to operate on *gliomas of the optic chiasm*, because they are accessible and also doubtless because the patients being otherwise so well the surgeon dislikes to sit idly by while they go blind. But the results do not justify the trouble. Rarely one may be removable, at least in part, by sacrificing the vision of one eye (Echols, 17), but nearly always the surgeon looks and withdraws. Examination of these tumors at necropsy reveals the

causes of these difficulties of removal (Fig. 4). Nearly always the tumor invades the hypothalamus and often also the optic nerves as far as the optic chiasm. When the hypothalamus is involved complete removal is out of the question. A simple exploration may provoke a fatal hyperthermia. Even removal of the intraorbital extension by ophthalmologists has resulted in death.

There remains for these tumors only roentgen radiation which seems sometimes to be very effective.

Rarely also a glioma projecting into the third ventricle may be removed in part without too much damage to the hypothalamus (Oldberg and Eisenhardt, 27).

The following case is illustrative of the usual futility of an operation in these tumors of the optic chiasm and hypothalamus.

Case 5. E. M., a girl of 13 years, was admitted to the University of Chicago Clinics (Unit No. 8952) on December 31, 1928, referred by Dr. Thomas Allen of Chicago.

History. She had scarlet fever and a tonsillectomy but was considered a normal healthy child. She was born normally on November 16, 1915 and developed normally. About a year before admission she began to menstruate. The last menses began on December 11. The mother dated her illness from a blow on the head two years previously which had rendered the child unconscious for an hour. From that time she began to have occasional headaches accompanied by vomiting. The only symptom previous to this accident which might be connected with the present illness was enuresis which began at the age of eight, after she had been quite proper for some years. The mother did not remember that this enuresis was associated with any unusual thirst. The enuresis continued to the time of her admission. For the last two years also she had trouble with reading. Her school work deteriorated.

Examination. When admitted she was rather apathetic; there were no pigmented areas over the body and no neurofibromas. The breasts were well-developed. There was pubic, but no axillary hair. General physical and laboratory examinations otherwise were normal. The temperature remained closely around 37°C. The blood pressure was 132/70. She weighed 51.4 kg. and was 151 cm. high. The intake of water averaged 1650 cc. daily. The basal metabolism was not determined. The optic discs were choked 3–4 diopters, and were pale through the edema. The acuity was 0.6+2 in the right eye and 0.4–1 in the left. There was a homonymous right-sided hemianopia. The pupils were wide, equal and reacted sluggishly to light. The external ocular movements were normal. There was no nystagmus. The other cranial nerves were normal. The tendon reflexes were active and there was a bilateral Babinski sign. No sensory impairment was found over the body or extremities. No incoordination of the extremities was found by the usual tests, but the gait was slightly unsteady.

An X-ray of the head disclosed slight diastasis of the cranial sutures and increase in size of the sella whose floor was depressed and the anterior clinoid processes undermined. Some spots of calcification above the sella were inconspicuous. An attempt to visualize the optic foramina was not very successful. It was our impression that there was a glioma of the optic chiasm but the hemianopia was so complete, passing through the fixation point, that it was thought better to make a ventriculogram. Moreover the early and normal catamenia would be unusual with a tumor involving the hypothalamic region. So on January 8, 1929 a *ventriculogram* was made. The lateral ventricles were normally situated and slightly enlarged. The third ventricle was not seen. On January 9, the child had a convulsion

with vomiting, stupor and slow pulse. These symptoms disappeared with the injection intravenously of 50 cc. of 50 per cent glucose.

Operation. On January 11, 1929, a right transfrontal exploration was made by Dr. Bailey with ether anesthesia. The retraction of the frontal lobe disclosed the right optic nerve stretched over the surface of a bulging brownish mass to the left of it. This proved to be a solid tumor. Fragments were removed with a soft curette and found to be glioma. The wound was then closed with no attempt to extirpate the tumor. The left optic nerve was not seen.

Surgical specimen. The fragment of tissue was composed of neuroglia. The nuclei were oval and widely scattered. No mitoses were seen and no multinucleated cells. No differentiated neuroglia fibrils were seen. The cytoplasm lay in illy defined strands running mainly parallel. Although very degenerated and infiltrated with hemorrhage, the tumor seemed clearly to belong with the polar *spongioblastomas.*

Subsequent course. The patient recovered promptly with very little alteration in pulse and temperature. On January 21, X-ray treatment was begun directed at the optic chiasm. Between that date and January 30 450 r-units were given. The child seemed not to be upset by the radiation but on February 1 she was found to be completely blind. There was almost no swelling of the optic discs. On February 4, she had an attack with opisthotonus and stupor for several hours, but the next day she was again better. On March 8, 1929 she was discharged bright and apparently well except for total blindness. On February 28, 1929, better X-ray films had demonstrated clearly the dilatation of the left optic canal. The right optic canal was normal.

On November 22, 1929 the left eye was blind, but the patient could count fingers with the right eye. The field of the right eye was reduced in what appeared to be a general constriction but examination was difficult. Both optic discs were white but in the right eye the margins of the discs were blurred. The child was feeling well, and X-ray treatments were begun on November 24. Until December 13, 1215 r-units were delivered in the left and right temporal regions.

Her condition remained practically unchanged. She even regained some vision in the rignt eye. On April 7, 1930, further radiation was undertaken but the patient went into an epileptic convulsion during the first treatment. She became unconscious, the pulse dropped to 64 and respirations were irregular. Puncture of the right lateral ventricle with a lumbar-puncture needle promptly alleviated the symptoms, but after a few days a recurrence of the symptoms led to a right subtemporal decompression on April 16, 1930 by Dr. Bucy. The condition then improved and radiation therapy was resumed and continued after her discharge on April 29.

Her condition remained again unchanged. Until July 12, 2128 r-units were given without outward results. When last heard from on September 27, 1934, she was said to be quite apathetic, untidy and blind. The decompression was said at times to be tense but she did not suffer from headaches. She had grown quite stout.

COMMENT

A satisfactory X-ray photograph would have established the diagnosis without ventriculography. The homonymous hemianopia is in all probability the result of the predominant involvement of the left optic tract.

There is little to say about other gliomas in the supratentorial region. *The ependymal*

tumors have been operated on with variable results (Tönnis and Zülch, 30; Fincher and Coon, 21). The other types are very rare.

But the group of gliomas in the posterior fossa (pontine and bulbar cases excepted) demands more detailed consideration. The ependymomas are frankly disappointing. We have a 50 percent mortality; Cushing 26.3 percent. "When situated in the fourth ventricle the operation is very hazardous", says Ford (22). And Cushing, "The temptation consequently is strong to attempt their total removal, but owing to their dangerous position this has usually led to a fatality." Vincent, Rappoport and Roudinesco (33) have described graphically the usual course of events: "Here is how things usually happen. One removes the portion of the tumor which fills the fourth ventricle methodically, without hemorrhage. There has been no alteration of respiration, no fall of blood pressure. One has talked with the child throughout the operation and agreed with him concerning the toys he will have when he is well. He was returned to his bed in good condition. During the first hours all is well—respiration 20 to 24 per minute, swallowing normal, temperature practically normal. His nose becomes warm. But now, from the fourth to the twelfth hour, in ten minutes, the respirations increase from 24 to 40, swallowing becomes difficult. From this moment, whatever one has hitherto done, the respirations increase, the bronchi fill with edema which appears in the mouth as a sort of foam. Finally the child succombs from increasing respiratory difficulty. If one opens the wound of such patients everything is found in order, no hemorrhage, no edema. Useful operations for ependymomas are excessively grave". The ependymomas appear favorable for operation. They are often attached by a broad base to the floor of the fourth ventricle, (Fig. 5), it is true, but are rather sharply circumscribed. But practical experience has shown that there is no feasible plane of cleavage for dissection and the attempt to separate the tumor from the bulb by sharp dissection nearly always ends disastrously. Especially the use of the electro-surgical scalpel is followed by serious complications which seem to arise from secondary circulatory troubles in the bulb. At present it seems wise to be content with a decompression.

The dangers and disappointments which attend upon the surgical treatment of these tumors is illustrated by Case 6.

Case 6. On the 6th of December, 1934, V. A., a boy thirteen years of age was admitted to the University of Chicago (Unit No. 117847). He was referred by Dr. F. Maurer of Peoria, Illinois.

History. His birth on June 14, 1921 and early development were normal and he had no serious illness in childhood. His present illness started in June 1934, with a sudden attack of dizziness and weakness in which he fell forwards. He was quite conscious and did not vomit. These attacks of giddiness persisted, and in August he began to have attacks of sudden vomiting as well. He was able to attend school during September and October, but he complained at this period of defective eyesight and of double vision. His walking became unsteady in October and this difficulty gradually became more severe. Headache had never been severe or frequent. For six weeks he had been troubled with increased salivation.

Examination. Percussion of the head gave a definite Macewen's sign and the X-ray photographs

of his skull showed slight separation of the sutures, increased digital marking and flattening of the sella turcica with erosion of both the anterior and the posterior clinoids. There was padilloedema of about 2 diopters in both fundi, but he could see to read. Outward movement was limited in both eyes and there was a very slight nystagmus in both eyes on looking to the right and on looking to the left. A rotatory nystagmus appeared in both eyes on looking upwards. The deep reflexes were symmetrically reduced and the plantar responses were flexor. All the limbs were hypotonic but there was no rebound phenomenon. Voluntary movement showed very slight incoordination in the action of the left hand and none in any other limb. He walked with his feet wide apart and with the left shoulder higher than the right, but there was no swaying. There was slight tenderness in the suboccipital region but his neck was not stiff. The diagnosis of a midline posterior-fossa neoplasm was made.

Operation. On the 15th of December, 1934 Dr. Bucy performed a suboccipital exploration under local anesthetic. After the dura mater over the cerebellum was incised it was seen that the tonsils of the cerebellum were herniated down through the foramen magnum. When these were retracted upwards and laterally, the posterior portion of the fourth ventricle and the posterior part of the bulb could be seen to be quite normal. The vermis was then incised and at a depth of about $3\frac{1}{2}$ cm. a reddish-brown tumor was exposed. This appeared to grow from the roof of the fourth ventricle, to extend more to the right side than to the left and to fill the anterior portion of the ventricle. The tumor was very vascular and there was considerable bleeding during its partial removal by sucker and rongeur. Enough was taken away to free the obstruction of the fourth ventricle and then the dura mater was left open and the wound closed.

Surgical specimen. The cells had abundant cytoplasm, definite cellular membranes and formed a mosaic. Around some of the blood vessels they lay in radial arrangement. A few of the cells had long processes which stained with methods for neuroglial fibrillae and there were a few cavities lined with cuboidal cells. No mitotic figures were found. Many of the cells contained groups of blepharoplasten. The tumor was a typical *ependymoma.*

Subsequent course. After the operation lumbar punctures were made each day, until his discharge on the 13th of January, 1935, and in addition he received 1025 r-units of roentgen radiation to the skull delivered in five treatments. When he left the hospital he was able to read a newspaper with his right eye, but the vision of his left eye was too poor to give him anything but appreciation of movement. He was able to walk alone but he was unsteady and tended to deviate to the right side.

By June, 1935, he was able to see very well with each eye and showed only slight cerebellar signs on both sides of the body, but he complained of frequent attacks of nausea and vomiting. One year later, in June, 1936, his gait had become again unsteady and he had marked ataxia in the movements of his left hand and arm. He was given 1095 r-units of radiation over the cerebellum in October, 1937. But there was no improvement. On January 5, 1938 he was readmitted, somewhat drowsy and vomiting frequently. His speech was slurred. The optic discs were pale and slightly elevated. There was a skew-deviation of the eyes. Gross nystagmus was evident on any attempt to deviate the eyes. All of the extremities were hypotonic and ataxic. His gait was very unsteady. The suboccipital region was bulging and tense. It was difficult for him to start the stream of urine.

Second operation. On January 6, 1938 Dr. Bucy reopened the suboccipital region under ether anesthesia. The tumor was rather readily separated from the cerebellum in its posterior portion but anteriorly was firmly adherent to the anterior medullary velum and the floor of the fourth ventricle. All

of the tumor was removed, with the electric loop, level with the floor of the fourth ventricle, except for a small portion which extended forward around the aqueduct of Sylvius, a drain was left in the bed and the wound closed. A transfusion of blood was given during the latter part of the operation and he seemed little upset by it but his temperature rose to 105° and remained around this level until his death on January 26, 1938. He never did regain consciousness, had several generalized convulsions and involuntary twitchings of all the extremities. The drain discharged serosanguineous material profusely which changed to pus before his death.

Surgical specimen. The tumor removed did not differ from the first surgical specimen except that there was an almost universal vacuolization and fatty degeneration of the neoplastic cells.

Autopsy. An examination was made six hours postmortem by Dr. W. Strykes. Nothing abnormal was found in the viscera. The base of the brain below the hypothalamus and the ventral surfaces of the cerebellum and brain stem were plastered with a thick yellow mass of friable material. The vermis overlying the fourth ventricle was missing from operative defect. Coronal sections through the brain stem revealed multiple reddish-brown areas about the aqueduct of Sylvius and the fourth ventricle and a thick, granular, friable, yellowish ependyma lining the aqueduct. Yellow, relatively firm tissue, probably remnant of tumor, remained attached to the anterior part of the floor of the fourth ventricle. Coronal sections through the cerebral hemispheres showed dilated ventricles with an ependyma thickened to 1-2 mm., easily separable from adjoining brain, and nodular, friable and yellowish-green on the inner surfaces.

Microscopical examination revealed a widespread purulent ependymitis and meningitis, haemorrhages around the aqueduct of Sylvius and in the bulb and remnants of tumor in the floor of the anterior part of the fourth ventricle.

Of the tumors in the inferior vermis we may consider the sarcomas and medulloblastomas together. Both are malignant and with difficulty distinguished from one another even under the microscope. It is doubtful whether one has ever been removed completely and successfully. Sachs (28) always points to his case XIII in a boy of three years in which we confirmed the diagnosis of medulloblastoma. But this child is known to have had a spinal extension and is doubtless long since dead. Elvidge, Penfield and Cone (20) record another instance of survival over seven years, but the diagnosis is suspect; the patient was twenty-three years old and the tumor had an abundant stroma of connective tissue. Eisenhardt (18) also reports a survival of more than seven years; one in over seventy cases. But usually the patients who survive operation live only one to five years, even with intensive roentgen radiation and repeated operations. The immediate surgical mortality in Cushing's material was 26.3 percent. Operating more conservatively for purposes of biopsy and immediate relief of symptoms with no attempt at complete removals our mortality was 15.4 percent. One patient died of infection and the other from delay in making a transfusion. Operating in such a conservative fashion the mortality should be less than 10 percent. Certainly when at operation implants can be seen in the leptomeninges with the naked eye no extirpation should be attempted (Fig. 6). For the other cases each surgeon must judge for himself so long as we cannot make a pre-

operative diagnosis of pathological type. Our attitude toward this problem is essentially in agreement with that of Elsberg and Go'ten (19). Familiarity with a few necropsies on these tumors certainly inhibits one's desire to struggle for a complete extirpation ; it is so obviously impossible (Fig. 7). The same remarks hold also for the sarcomas. Even when the tumor seems localized and circumscribed experience has shown that it inexorably recurs after removal.

Postoperative roentgen radiation is very effective in checking the growth of the medulloblastomas (Bailey; Sosman, van Dessel, 7), but even with this aid survival beyond five years is excessively rare. And too intensive radiation may provoke fatal degenerative changes in the nervous system (Bailey and Brunschwig, 4). Because of the tendency of these tumors to spread in the leptomeningeal spaces the entire neuraxis should be radiated in every case, even when there are no symptoms pointing to involvement of distant parts of the central nervous system.

The following two cases present the usual course of events with these malignant tumors of the posterior midline of the cerebellum. The first is a medulloblastoma, the second a sarcoma of the meninges. The similarity in the symptomatology as well as in the picture present at operation and the microscopic appearance is evident.

Case 7. On the 8th of June, 1929, E. A., a girl aged eight years was admitted to the University of Chicago Clinics (No. 12560). She was referred by Dr. Max Peterman of Milwaukee.

History. She was born normally on December 23, 1920. Her infancy was quite normal and her symptoms started with headaches in February, 1929. Because of these her eyes were examined and it is said that the diagnosis of brain tumor was suggested at that time but nothing was done until May when she was taken to the Children's Hospital in Milwaukee. There she continued to have headache and vomiting and she was transferred here with the diagnosis of cerebellar tumor.

Examination. The child was moderately cooperative and was obviously unsteady and uncertain in the movements of her limbs. She had a papilloedema of about five diopters in each eye with some fresh haemorrhages on both discs. There was no limitation of conjugate movement of the eyes in any direction but there was a lateral nystagmus in both eyes on looking both to the right and to the left. There was a slight diminution of the right corneal reflex and a definite right facial weakness.

The deep reflexes were all symmetrically diminished and the plantar responses were both flexor. The limbs were hypotonic but there was no gross incoordination of the arms or legs when lying down although she walked with a very ataxic gait. X-ray photographs of the skull showed only a separation of the sutures.

It was thought that the child had the signs and symptoms of a midline cerebellar tumor.

Operation. On the 10th of June, 1929, Dr. Bailey exposed the posterior fossa, under ether anaesthesia, making the usual cross-bow incision. The midline incision was continued downward and the arch of the atlas removed. When the dura was opened a grayish tumor could be seen extending downward between the tonsils of the cerebellum as far as the level of the atlas. This tongue of tumor was free and was easily separated from the underlying cord and the cerebellum. An incision was then made in the vermis down to the tumor and as much as would come easily away was removed by suction. The patient's condition was excellent throughout the operation.

Surgical specimen. The fragment was composed of tumor tissue somewhat infiltrated with fresh blood but with no degenerative changes. The nuclei were closely crowded together, oval in shape, and heavily stained. Mitotic figures were very numerous. There were a few delicate cytoplasmic strands but no fibrillae. A few small vascular channels were present and there was no connective tissue apart from their walls. The tumor looked like a typical *medulloblastoma*.

Subsequent course. The child recovered easily and well from the immediate effects of the operation and when she was discharged three weeks later she could stand and walk quite steadily and was free from all headache and nausea.

She lived for one year and one month after the operation and until four weeks before her death she was free from all symptoms and showed only slight defect in her gait. As the tumor tissue removed at operation was typical of a medulloblastoma she was given X-ray treatment over the entire skull and spine. This was given in forty doses divided into six groups throughout the year with a total of 3160 r-units to the skull and 5422 r-units to the spine. Four weeks before her death she complained of pains in her legs but at no time did she show any signs of a paraplegia. She died after having been in stupor for three days, provoked by an attempt to repeat the roentgen treatments over the cerebellum.

Autopsy. Complete examination was made by Dr. E. R. Long two hours postmortem. Nothing abnormal was found apart from the central nervous system. The lateral ventricles of the brain were moderately dilated and the convolutions of the cerebrum flattened. The surface markings of the cerebellum were obscured by tumor which had infiltrated the leptomeninx over almost the entire surface of the cerebellum and extended through the basilar cistern beyond the optic chiasm along the anterior cerebral vessels to above the rostrum of the corpus callosum (Fig. 6). The interpeduncular cistern was completely filled with tumor and one nodule about a centimeter in diameter projected into the third ventricle back of the stalk of the hypophysis. There was a large nodule of tumor 1 cm. in diameter on the posterior surface of the spinal cord at C_2 and a smaller nodule in the cauda equina. Grossly no infiltration along the Sylvian vessels could be seen. On the medial sagittal section a large nodule 4 cm. in diameter was seen in the vermis cerebelli just above the fourth ventricle which was practically obliterated. The tumor, moreover, was attached to the floor throughout the greater part of its extent. The anterior medullary velum was free of tumor which had arisen back of the fastigium and extended forward to fill the anterior part of the fourth ventricle as a short fat tongue, which, however, stopped about 1 cm. posterior to the posterior orifice of the aqueduct.

Microscopical examination confirmed the gross impression of infiltration of the leptomeninges from the olfactory bulb to the cauda equina. There was infiltration even into the Sylvian fissures and on to the medial surfaces of the frontal lobes as far as the rostrum of the corpus callosum. Dense masses had accumulated all along the basilar cistern, over the superior surface of the cerebellum and over the dorsal surface of the second cervical segment. Generally the tumor had respected the pia-glia membrane, but had extended along the perivascular sheaths at some places several millimeters into the cerebral cortex and actively invaded the second cervical segment of the spinal cord. It had also destroyed the ependymal floor of the fourth ventricle and invaded the bulb.

Over the inner surface of the frontal lobe there was a thin sheet of tumor, with scanty cells and great thickening of the connective tissue. The tumor extended down into the sulci, but had invaded the cortex of the brain along the vessels only very superficially.

The main mass of tumor above the fourth ventricle was much degenerated in scattered foci. The

nuclei varied greatly in size and numerous multinucleated cells were present. The walls of the blood vessels were hypertrophied, but there was no tendency to the formation of a connective-tissue stroma. A few abnormal mitoses were seen. The cytoplasm of the cells was scanty and ran in irregular strands among the nuclei.

The tumor in the leptomeninx at C_2 was degenerated, with considerable overgrowth of connective tissue. Numerous multinucleated tumor giant-cells were found and a few abnormal but unquestionable mitoses. The tumor had compressed and actively invaded the right posterior column, between the posterior septum and the dorsal horn, to a depth of 3 mm. It had followed along the sheaths of the blood vessels even deeper than the main mass. There was a slight superficial gliosis of the cord beneath the tumor.

Small nests of neoplastic cells were found in the leptomeninx at the midthoracic level giving evidence of infiltration with tumor in regions where it did not appear grossly. The spinal cord itself in this region appeared normal.

The nodule of tumor in the cauda equina was identical in structure with the cerebellar lesion. The roots and filum terminale had not been compressed by the tumor and appeared normal in structure.

Everywhere the tumor was much degenerated. The nuclei were pyknotic and there was a considerable overgrowth of connective tissue. Numerous multinucleated cells were present and abnormal mitoses. The tumor was a *medulloblastoma* which had spread throughout the subarachnoid spaces.

COMMENT

The clinical course of this patient was fairly typical of a medulloblastoma except for the sudden death following radiation. This was doubtless due to the fact that there was a larger tumor mass in the vermis than we have seen in other cases after radiation. It is an example of what might well happen if the suggestion of Cutler and Sosman and Voughan (14) were carried out to try radiation before operation in these cases. She was in excellent condition before the radiation was given, had been running and playing like a normal child and was only slightly unsteady on her feet in the tandem position. Of course, the ultimate outcome would have been the same as we know from other cases which received much more radiation.

Case 8. V. H. was admitted to the University of Chicago Clinics (Unit No. 61565) on the 7th of June, 1932. She was a girl of eleven years who was referred by Dr. Joseph Brennemann of the Children's Memorial Hospital of Chicago.

History. This child was born at full term on February 5, 1921 after a normal pregnancy and a normal delivery. She sat up, walked and talked at the usual age and had no serious illness at any time. The only infectious diseases that she had were measles, mumps and scarlet fever. She did well in school and was normal in every way until April of 1932. Then she began to have attacks of vomiting each morning which were not associated with any general illness. These attacks persisted and became more frequent until they came on two or three times each day. When the frequency of the vomiting attacks increased she began to have sévere bursting headaches every day and during May it was noticed that she became unsteady in her walking and that she tended to stagger to the right side. During the two weeks before admission she had two seizures in which she was unconscious for a few minutes and then unable to talk for a longer period. Because of language difficulty and general lack of cooperation and

understanding it was impossible to get more details of these attacks. The girl herself made no complaints of defective vision at any time.

Examination. Her fundi showed papilloedema of about 1 diopter in each eye without any haemorrhages. The pupils were widely dilated and reacted normally. There was no limitation of conjugate movement in either eye in any direction but there was a slow nystagmus in each eye on looking to the right, to the left and upwards. This nystagmus was symmetrical in the two eyes. The cranial nerves were otherwise normal. The deep reflexes were all reduced, and there was hypotonia in all four limbs. There was very little ataxia in her arms but rapidly alternating movements were poorly performed by both hands. When she walked, her gait was ataxic and she tended to walk over to the right side. Her head was held in the middle line but her arms did not swing freely. X-ray photographs of the skull showed no abnormality. It was thought that the girl had a rapidly growing tumor in the vermis of the cerebellum.

Operation. Dr. Bucy explored the posterior fossa on the 9th of June, 1932 under ether anaesthesia. When the dura mater was incised the vermis was found to be much distended and the tonsils of the cerebellum to extend down through the foramen magnum into the uper part of the spinal canal. For this reason the posterior arch of the atlas was removed and the dura mater incised down to the level of the second cervical vertebra. When the vermis was explored a reddish gray tumor was found which was very vascular. A few fragments were removed for immediate microscopical study. The wound was then closed.

Surgical specimen. The biopsy specimen consisted of cerebellar cortex invaded by tumor. The neoplastic cells had little cytoplasm. Their nuclei varied greatly in size and multinucleated cells were seen. The nuclei were wrinkled and did not have the typical appearance of the nuclei of a medulloblastoma but the rapid fixation was held responsible and the tumor interpreted as a *medulloblastoma.*

Subsequent course This girl recovered very easily and very quickly from the immediate effects of the operation and deep X-ray treatment was started eleven days later. In fourteen treatments she was given a total of 3850 r-units, 2200 r-units being given to the skull and 1650 r-units to the spinal axis. She developed a superficial infection of the wound which was slow in healing and she did not leave the hospital until two months after the operation. Her condition then was not as good as would normally have been expected since she had almost daily vomiting and the decompressed area had an underlying cystic cavity which intermittently filled with spinal fluid and which had to be aspirated every seven to ten days.

On the 18th of August, 1932 she was brought back to the hospital with a history of having had difficulty in swallowing for three days and inability to speak for forty-eight hours.

Re-examination. The decompressed area then was tense and bulging and 65 cc. of fluid were removed. The fundi were not swollen, there was an almost complete palatal and pharyngeal paralysis, the deep reflexes were all absent and the child was unable to sit up, stand or walk. She lived until the 5th of September and the decompressed area was aspirated daily, with from 25 to 50 cc. of fluid being removed. On the 26th of August deep X-ray treatment was resumed and in these treatments 592 r-units were given to the skull. However, she slowly became more emaciated and finally died on the 5th of September, 1932.

Autopsy. An examination, restricted to the brain and spinal cord was made eight hours postmortem by Dr. H. Winters. The cerebral convolutions were slightly flattened. There was no evidence

of invasion of the leptomeninx over the cerebellum and base of the brain. Between the cerebellar hemispheres posteriorly there was a neoplastic mass 3 cm. in diameter, occupying the position of the posterior vermis and displacing the cerebellar hemispheres laterally. Sagittal section of the brain showed this tumor to extend 6.5 cm. in the antero-posterior diameter. It had not invaded the anterior vermis which was displaced forwards and upwards. It had compressed the posterior part of the bulb but it was not attached to the floor of the fourth ventricle. The cut surface of the tumor was soft, pinkish and friable.

There were no gross nodules of tumor along the spinal cord or cauda equina but the leptomeninx appeared diffusely thickened especially over the posterior surface of the cord.

Microscopically the tumor was shown to have spread through the subarachnoid space from the optic chiasm to the cauda equina but had nowhere invaded the nervous tissue. The tumor itself in the fourth ventricle was composed essentially of a mass of neoplastic cells with scanty thin-walled blood vessels. The cells lay loosely and usually without architectural arrangement but they had considerable cytoplasm and definite cellular boundaries. The nuclei varied greatly in size and numerous multinucleated cells were present. Definite mitoses were rare. Degeneration was extensive. There was an abundant meshwork of reticulin and collagen which permeated the tissue in every direction, sometimes dividing the cells into alveoli. These connective-tissue fibrils were not formed by organizing fibroblasts, but apparently by the tumor cells themselves. In spite of the location of the tumor mass it was not a medulloblastoma but a *sarcoma* of alveolar type.

COMMENT

It should be noted that this tumor did not respond to roentgen radiation as readily as a medulloblastoma would have done. Under the microscope it was very readily distinguishable by the abundant fibrils of reticulin formed by the neoplastic cells. The cells themselves were more irregular in shape and volume and had more irregular vesicular nuclei.

We come at last with a great sense of relief to the *astrocytoma of the cerebellum.* This is a tumor about whose treatment one can speak enthusiastically. The indications are clear and the results excellent. When we learn to diagnose with certainty this tumor the physician can give advice concerning it with assurance and optimism. At present we must say usually that the child has almost certainly a tumor in the cerebellum and there is better than an even chance that it is an astrocytoma in which case—at this point begins the optimism. Since Martin showed that the mural nodule in cystic gliomas must be removed to secure permanent relief the unanimous testimony indicates that the astrocytoma of the cerebellum is a benign lesion very favorable to surgical treatment. Cushing's mortality for his entire series was 11.2 percent but for his last 29 cases it was only 2.9 percent. Our own mortality for twenty cases was 5.0 percent. We have already noted that such figures may mean little. The beauty of it is that the vast majority of these patients remain well. Of our own 20 cases 17 are living after long periods, most of them entirely well, although a few are blind through no fault of ours. Two died after operation for recurrence of symptoms, and one of intercurrent disease. Of Cushing's cases 35 are living after operation five years or longer, some of them over twenty

years. The treatment of astrocytoma cerebelli is one of the great triumphs of neurological surgery. When we feel depressed we get back our astrocytomas and look at them until our spirits rise and we are encouraged to continue the fight against this curse of mankind.

The following three cases present some of the problems and the results of treatment in these cases.

Case 9. L. M., a girl aged twelve years, was admitted to the University of Chicago Clinics (Unit No. 24656) on July 5, 1930, referred by Dr. A. R. E. Wyant of Chicago.

History. She was born normally on the 24th of August, 1917 and developed normally. She had whooping cough at the age of three years, measles at five years, and scarlet fever at seven years. The tonsils and adenoids had been removed. But she had always been considered a healthy child and did her school work well until early in June, 1930, when she began to have frontal headaches and nausea ending in vomiting. These bouts of headache and vomiting continued at intervals until August 19, 1930, when she was admitted to the hospital.

Examination. She was a tall, well-developed girl. General physical and laboratory examinations were normal. There was possibly a cracked-pot sound when the head was percussed. The pupils were large and the pupillary reactions were normal. There was a slight nystagmus, poorly sustained, on the lateral gaze, more to the right side. The optic discs were blurred and the veins congested with an elevation of 3–4 diopters. The visual fields were normal. Slight weakness of the right side of the face indicative of involvement of the peripheral nerve was noted. External ocular movements were normal. The other cranial nerves were normal. There was no stiffness of the neck. All extremities were hypotonic, more on the right side, but there was very little incoordination by usual tests. The tendon reflexes were normal; no clonus or Babinski sign. There was very slight unsteadiness of gait, brought out on walking a line, with greater tendency to fall to the right. No sensory loss over the body was revealed. X-ray examination of the head showed the sutures to be possibly slightly dilated, slight erosion of the sella turcica and slight convolutional markings on the inner table. A diagnosis of cerebellar tumor was made, probably predominantly in the right hemisphere.

Operation. On August 28, 1930, under ether anesthesia, a suboccipital exploration was made by Dr. Bailey. The right cerebellar hemisphere was fuller and an incision into it came down upon the grayish surface of the tumor about 1 cm. under the surface. The tumor was cystic and contained about 30 cc. of yellowish fluid. The cyst was surrounded by a shell of tumor about 3 mm. in thickness which was dissected out with very little bleeding. A transfusion of blood was given at the end of the operation, after which she recovered promptly. The wound healed well, the swelling of the optic discs subsided and she was ready to be discharged when she developed a boil on the buttock which delayed her discharge until January 30, 1931.

Surgical specimen. The tumor proved on microscopical examination to be an *astrocytoma.* The tumor consisted essentially of astrocytes. The neoplastic cells were widely separated by a feltwork of neuroglial processes, in some areas very dense, in others separated by edema, in still others degenerated to form cystic spaces of microscopic size. The neuroglial cells were mainly protoplasmic, although in certain areas neuroglial fibrils were differentiated. Blood vessels were very rare and thin-walled.

Subsequent course. She has been entirely free from symptoms and has remained well. She was last seen on Aug. 25, 1938.

COMMENT

This was a straightforward case of astrocytoma with an excellent result. These tumors are usually cystic and often sharply circumscribed (Fig. 8) as in this case, greatly facilitating their removal. It was impossible in this case to be sure that the tumor was not a medulloblastoma, but the sex and age of the patient and the unilaterality of the cerebellar signs were against this possibility. The clinical history was very short and gave no clew to the pathological diagnosis.

Case 10. J. L., a boy aged ten and a half years, was admitted to the University of Chicago Clinics (Unit No. 24174) on the 21st of June, 1930. He was referred by Dr. Katherine Mayer of Chicago.

History. The child was born normally, breast-fed, and developed normally. He had pneumonia at one year and measles and chicken pox at the age of five. He had always been considered to be a normal child until about six months before admission, when he began to have recurrent headache accompanied by vomiting. He became listless, shaky and irritable and in April his left eye turned in. The day before admission he had a very severe headache, vomited, became stuporous and rigid and finally unconscious.

Examination. General physical and laboratory examinations were normal. The child was stuporous, the head was large and there was a definite cracked-pot sound when it was percussed. Both optic discs were elevated about 2 diopters and the visual fields were normal. There was a left external rectus weakness, but there was no nystagmus in any direction. The pupils reacted normally. The right masseter muscle was weak. The corneal reflexes were both brisk. There was a right peripheral facial weakness. There was hypotonicity and incoordination of the right arm and leg, with a rebound phenomenon in the arm. The deep reflexes were brisker on the right side than on the left and the right plantar response was equivocal. His gait was unsteady and he had a tendency to deviate to the right side. X-ray photographs of the skull showed dilated sutures, convolutional markings, a dilated shallow sella turcica and erosion of the dorsum sellae. The diagnosis was made of tumor of the right cerebella hemisphere in spite of the absence of nystagmus.

Operation. On the 26th of June, 1930, with ether anesthesia, a suboccipital exploration was made by Dr. Bucy. The right cerebellar hemisphere was found to be larger and tenser than the left and slightly yellowish in color. A large cystic cavity was found 1 cm. under the surface of the right hemisphere from which 45-50 cc. of a cloudy fluid was withdrawn. The cyst extended under the vermis but not much beyond the middle line. A yellowish gelatinous mass occupied the medial wall of the cyst was removed and preparations had been made to remove the mass in the medial wall when the condition of the patient made it necessary to abandon the operation and to close the wound as rapidly as possible. The blood pressure was 50/40 and the pulse 160 at the end of the operation.

Surgical specimen. Microscopic examination showed the tissue removed to be sclerotic cerebellar tissue with at one area a considerable accumulation of fibrillary neuroglial cells. The tumor in all probability was an *astrocytoma* of fibrillary type.

Subsequent course. His condition remained critical for three days, then he recovered rapidly and was discharged on the 5th of August, 1930. At that time he was feeling well but he walked unsteadily on a wide base. There was no nystagmus and the incoordination of his right arm was much

reduced. On the 12th of July, 1934, he had only a very slight awkwardness of the right hand and his gait was entirely normal. He had 0.8 vision in each eye and each optic disc was pale and flat. In May, 1938, he was working steadily as a machinist and, aside from slight unsteadiness of the left hand, had no symptoms.

COMMENT

Since the main mass of tumor was not removed it was expected that he would soon return but he has so far remained well. That recurrence and the necessity of a second operation are the usual results of an incomplete operation is shown by the following case but, as Cushing has pointed out with Case 5 of his series the interval between operations may be as long as 13 years and in very unusual cases (Hausman and Stevenson) the patient may survive for years without surgical intervention.

Case 11. On the 22nd of February, 1934, I. H. was admitted to the University of Chicago Clinics (No. 99463). She was a girl about eight years old who was referred by Dr. R. C. Bourland of Rockford, Illinois.

History. This child was the fourth of five children and her birth on April 30, 1926 and early development were normal. In September, 1932, when seven years old, she had an acute upper respiratory infection which left her for some weeks with weakness of the right shoulder. In December, 1932, she developed attacks of severe headache associated with vomiting which came on irregularly and were apparently not related to any general illness. In the spring of 1933 her walking became unsteady but she made no complaint at that time of any difficulty in vision. The headaches persisted until the summer of 1933 and when they stopped it was noticed that her head started to enlarge quite rapidly. At this same time she contracted scarlet fever and when in hospital for this illness the diagnosis of intracranial tumor was made. Her parents refused operation and by October, 1933, the girl had completely lost her vision. By that time she had developed in addition weakness of the right arm and right leg, clumsiness in the use of her right hand and slurring and indistinct speech. For at least a month before admission her walking had been so unsteady that she was completely confined to bed.

Examination. The child was lethargic. Her speech was slow and dysarthric. Percussion of her head produced a positive Macewen's sign and X-ray photographs of the skull demonstrated an enormous cranial cavity with marked separation of the sutures and some convolutional atrophy. The dorsum sellae was somewhat decalcified. There was marked thinning and downward bulging of the suboccipital region. The fundi showed secondary optic atrophy with no evidence of recent swelling and the child could probably appreciate bright light with the right eye but had no appreciation of form or color. The left eye was completely blind. The right pupil showed a very slight response to direct light but the left pupil was completely inactive. There was a slow nystagmus in both eyes on looking to the right side and a more rapid nystagmus in both eyes on looking to the left. Both corneal reflexes were reduced but the other cranial nerves were normal in action. The deep reflexes were absent in both arms and much reduced in the legs. The plantar responses were both extensor. There was severe hypotonia in all the limbs and incoordination in both arms. This incoordination was much more marked in the right arm than in the left. The ataxia and hypotonia in the legs was so severe that the child could not stand or walk. It was thought that the child had a cerebellar tumor which was situated predominantly in the right cerebellar hemisphere, probably an astrocytoma because of the long history.

She also had a congenital lesion of the heart, probably a patent interventricular septum. The heart was enlarged 52 percent according to the roentgenograms and the E. K. G. gave evidence of some myocardial damage.

Operation. On the 1st of March, 1934, Dr. Bucy explored the posterior fossa under local anaesthesia. The patient developed a major convulsion after the local anaesthetic was injected and was unconscious for some minutes. The left lateral ventricle was punctured and, after relief of the intracranial pressure, she regained consciousness and remained in good condition throughout the operation. The left cerebellar hemisphere appeared to be normal in size, in color and in consistency, but the right hemisphere was much enlarged, very firm, and yellow in color. When this hemisphere was incised no cystic cavity was discovered but a gray gelatinous tumor was exposed. This neoplasm filled the whole hemisphere and extended past the middle line, to the left side. Although there was no definite line of cleavage between the cerebellar cortex and the tumor the latter was slowly removed except for a portion lying just above and next to the bulb and pons. The superior cerebellar vein passing from the right cerebellar hemisphere to the superior longitudinal sinus was clipped and cut. The dura mater was left open and the wound closed.

Surgical specimen. The tumor was composed predominantly of protoplasmic astrocytes, but in some areas there were numerous oligodendroglial cells. The processes of the glial cells were in some areas matted together to form a pseudosyncytium and small cysts were scattered throughout the tissue. Blood vessels were rare and no mitotic figures were seen. There were no fully developed neuroglial fibrillae. The tumor was a protoplasmic *astrocytoma.*

Subsequent history. About three weeks after the operation the child was able to stand alone and then gradually she regained her ability to walk. By the end of the summer of 1934 she was able to walk up and down stairs unaided and had no defect apart from that resulting from her blindness. By October, 1934, she showed an amazing improvement and had regained light perception in both eyes. She entered the school for the blind at Jacksonville, Illinois, and there made an extremely good adjustment. Her condition remained excellent in every way until December, 1936. At that time she had a return of her headaches and of vomiting, and then showed unsteadiness and weakness in her right arm. During the last few days of December, she was almost completely helpless and was unable to feed herself or to stand or walk. She was readmitted to the University of Chicago Clinics on the 3rd of January, 1937.

Second examination. The circumference of her head was 58 cm. and percussion produced a positive Macewen's sign. The optic discs showed the picture of a primary optic atrophy although it was undoubtedly the result of the previous papilloedema. She had appreciation of light and of gross movement with both eyes, although she had no ability to distinguish form or color. The right pupil reacted very slowly to direct light and the left pupil reacted consensually. The conjugate movements of the eyes were full in all directions but there was a slow coarse nystagmus in both eyes on looking to the right and a more rapid nystagmus on looking to the left. She showed a cerebellar syndrome on both sides of the body but the hypotonia and incoordination was much more marked on the right side than on the left. This recurrence of signs and symptoms was believed to be due to the growth of that portion of the tumor which was not removed at the first operation, because of its attachment to the bulb and pons.

Second operation. Dr. Bucy reopened the posterior fossa on the 9th of January, 1937, under

ether anesthesia. There was a definite line of demarcation between the tumor and the cerebellar tissue and the neoplasm shelled out readily. However, the tumor was too large to be delivered through the opening which was present in the bone and a large quantity was removed in small pieces until the remainder could be easily delivered. In all over 111 grams of tumor were removed. When the extirpation was complete it seemed that no cerebellar tissue remained in the midline nor in the right side of the cerebellar fossa. This cavity was filled with saline and the wound closed.

She recovered very quickly from this second operation and left the hospital three weeks later. The last information obtained about her condition was by letter at the end of March, 1937. At that time she was free from all headaches and vomiting and could walk about quite well although she still had some defect in the use of the right arm and right leg.

COMMENT

The huge recurrent tumor disclosed at the second operation is not unusual and numerous similar examples have been recorded by Cushing.

At the termination of our study we are more than ever impressed by the importance of pathology for any rational program for the treatment of intracranial tumors. We do not feel inclined to adopt the attitude of Sachs (28) or of Dandy who feel that an attempt should be made to extirpate every tumor in the intracranial cavity regardless of its n ture and regardless of the results for the patient. If we could make a pathological diagnosis always before operation there are many cases which we would not attempt to treat in this way. So far we have refused to operate on several large craniopharyngiomas diagnosed by X-rays, and several gliomas of the brain stem diagnosed from the symptoms. We have had no occasion to regret our abstention. The great need, however, is for a method of differentiating between medulloblastomas and astrocytomas of the cerebellum. At present we make an exploratory operation and depend upon a biopsy to identify the nature of the tumor. Recently Cutler, Sosman and Vaughan (14), have proposed a method of preoperative diagnosis based on the well-established sensitivity of the medulloblastoma to roentgen radiation. They propose to radiate all cerebellar tumors in children before operation. Those whose symptoms improve would be medulloblastomas and would not be operated on. Time and experience will determine whether the method is well-founded. We have feared that some fatalities might result from edema provoked in the tumor by the radiation and have not ourselves attempted the method, but the conception points in the right direction.

The pathology and symptomatology of these tumors are sufficiently well understood, and the surgical technic is adequate. It remains only to distinguish before operation those operable from those inoperable, in other words to establish more definitely the indications for operation (Bailey and Ectors, 5). It is in this direction that research must now be oriented.

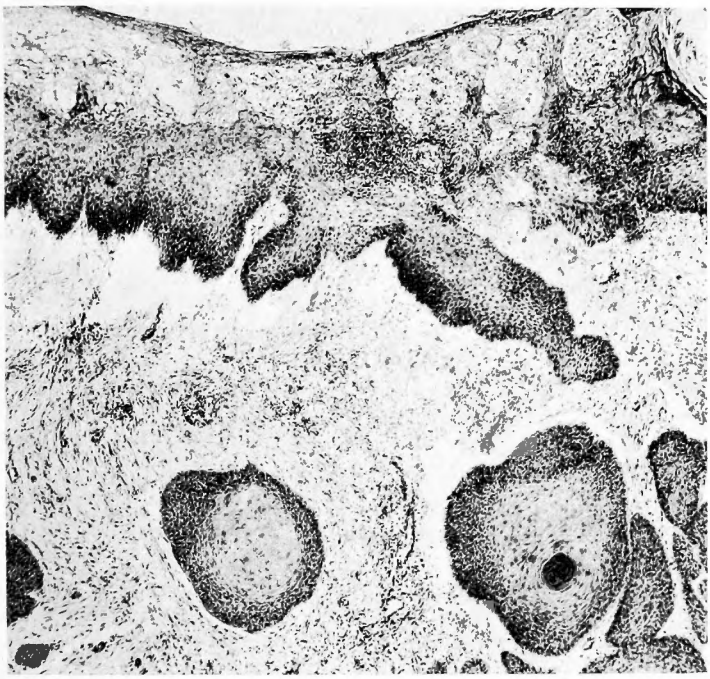

Fig. 1. Craniopharyngioma. Note the fingers of epithelial cells which project into the surrounding brain tissue.

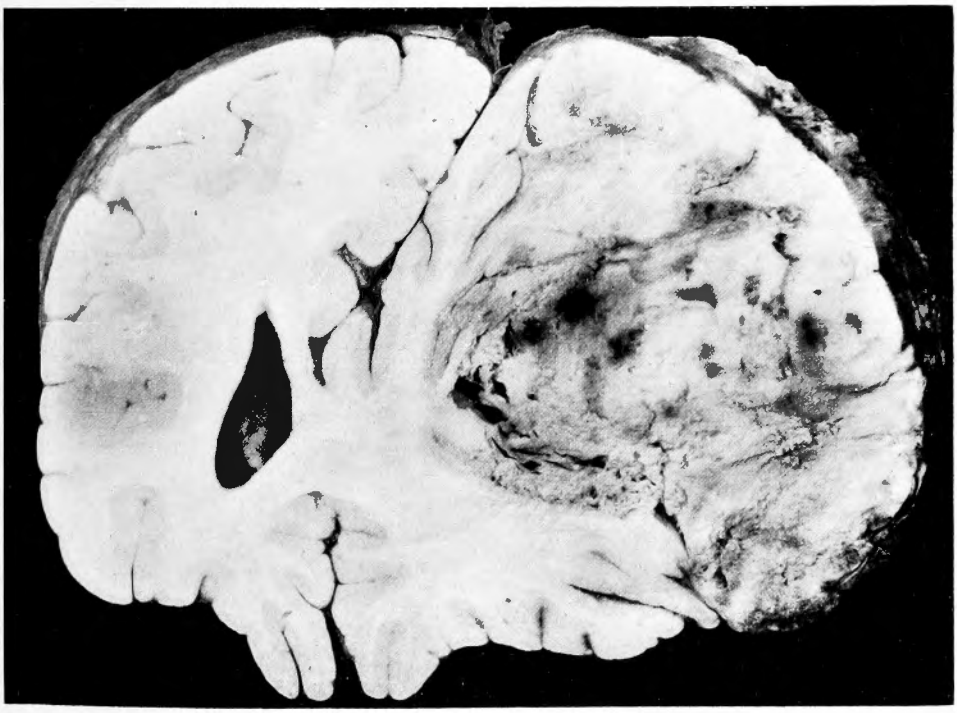

Fig. 2. Cross section of cerebrum containing a large invasive sarcomatous tumor arising from the leptomeninges.

Fig. 3. Nodular enlargement of the pons from diffuse intrapontine glioma.

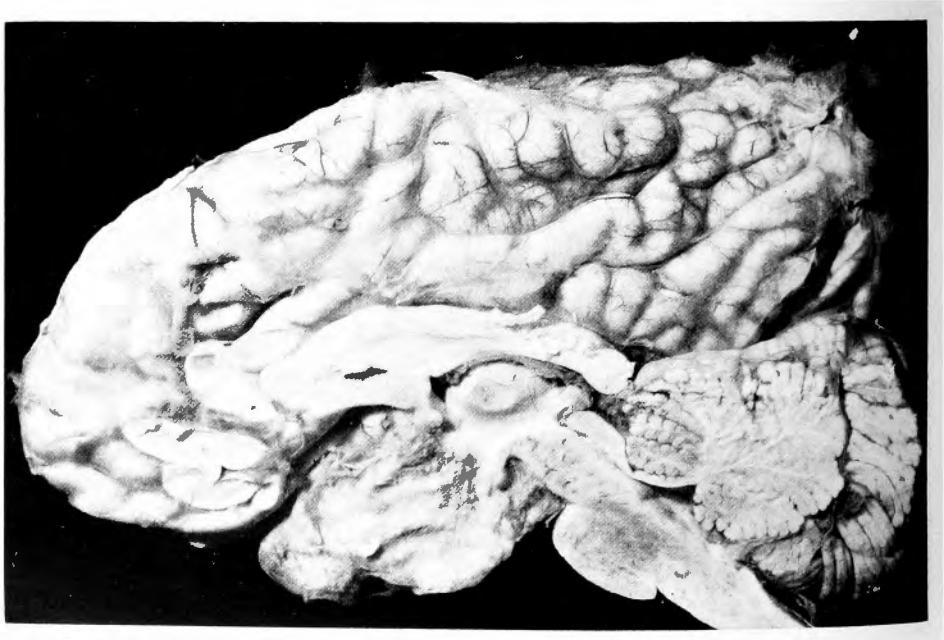

Fig. 4. Glioma of the optic chiasm. Note the extensive invasion of the hypothalamus.

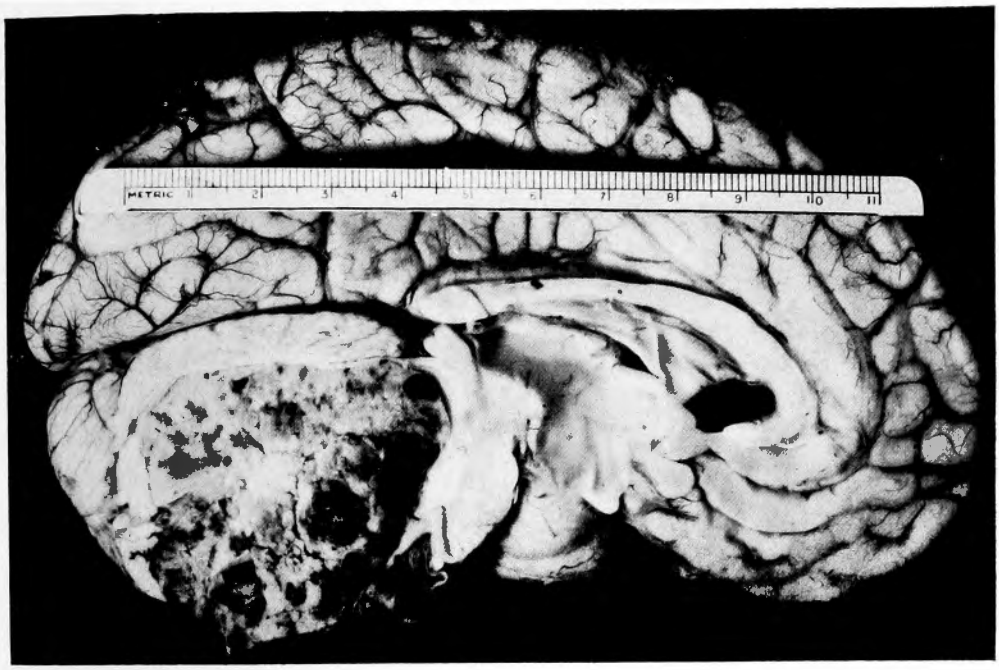

Fig. 5. Ependymoma arising from the floor of the fourth ventricle to which it is attached by a wide base.

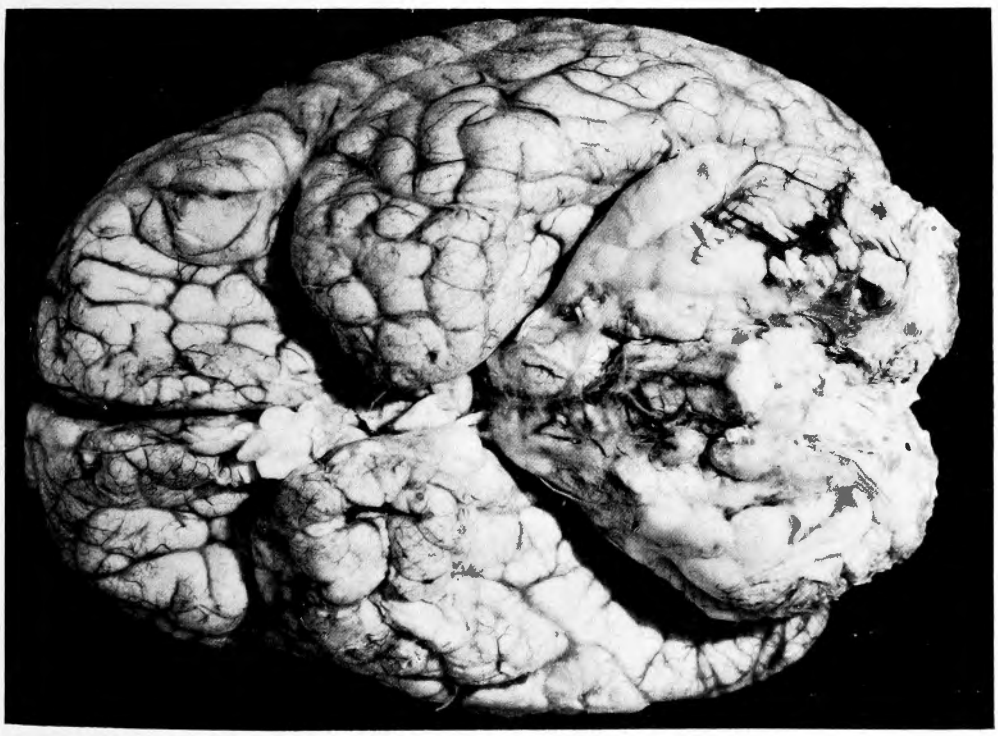

Fig. 6. Cerebellar medulloblastoma. The tumor can be seen to extend in the leptomeninges over the inferior surface of the cerebellum, pons and bulb.

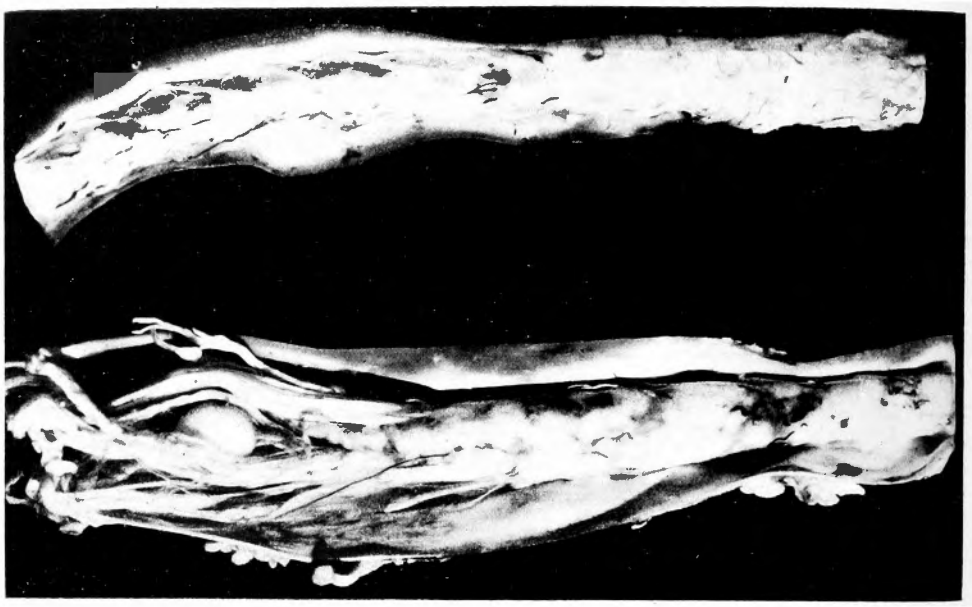

Fig. 7. Invasion of the leptomeninges of the spinal cord by a medulloblastoma arising in the cerebellum.

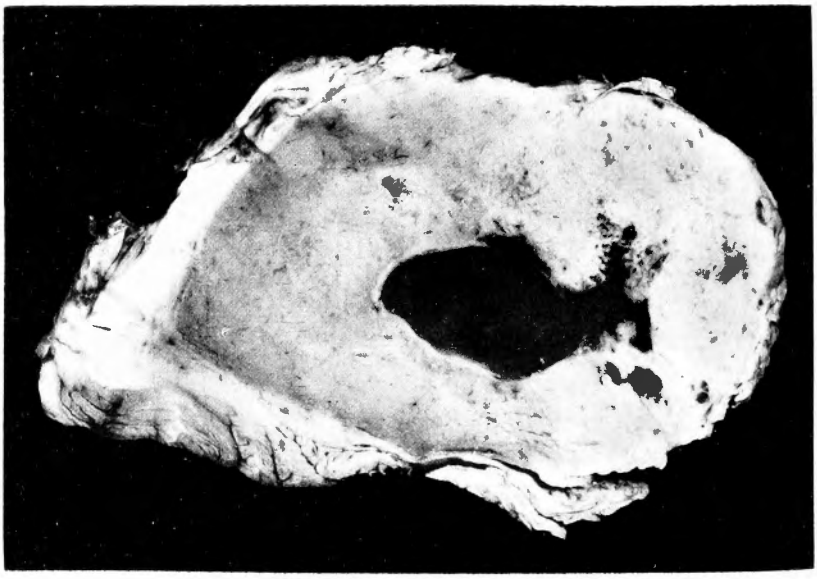

Fig. 8. Cystic astrocytoma of the cerebellum. Note the sharp margin of the tumor.

BIBLIOGRAPHY

1) Araki, Ch. Surgical removal of pineal tumors. A critical review of the literature. Arch. f. Jap. Chir. 1937: **14**, 1193–1206. 2) Araki, Ch. Meningioma in the pineal region. A report of two cases removed by operation. Arch. f. Jap. Chir. 1937: **14**, 1181–1192. 3) Bailey, P. Intracranial Tumors. Thomas, Springfield, 1933, 475 pp. 4) Bailey, P. and Brunschwig, A. Erfahrungen mit der Roentgenbehandlung der Hirngliome. Zts. f. d. ges. Neurol. u. Psych. 1938: 161, 214-217. 5) Bailey, P. and Ectors, L. Les indications opératoires dans la chirurgie des tumeurs cérébrales. Revue neurol., 1938: **2**, 459–470. 6) Bailey, P. and Herrmann, J. The role of the cells of Schwann in the formation of tumors of the peripheral nerves. Am. Jour. Path. 1938: **14**, 1–38. 7) Bailey, P., Sosman, M. C. and Dessel, A. van. Roentgen therapy of gliomas of the brain. Am. Jour. Roentgenol. 1928: **19**, 203–264. 8) Cairns, H. The ultimate results of operations for intracranial tumours. Yale Jour. of Biol. and Med. 1936: **8**, 421–492. 9) Camp, C. D. Tumors of the brain. Abt's Pediatrics. Lippincott, Phila. 1925: **7**, 421–435. 10) Critchley, MacD, Brain tumours in children. Brit. Jour. Dis. of Children. 1925: **22**, 251–264. 11) Critchley, MacD. and Ironside, R. N. The pituitary adamantinomata. Brain, 1926: **49**, 437–481. 12) Cushing, H. The intracranial tumours of preadolescence. Am. Jour. Dis. Childhood. 1937: **33**, 551–584. 13) Cushing, H. Intracranial tumours. Thomas, Springfield, 1932, 150 pp. 14) Cutler, E. C., Sosman, M. C. and Vaughan, W. W. Place of radiation in the treatment of cerebellar medulloblastomata: report of twenty cases. Am. Jour. Roentgenol. 1936: **35**, 429–453. 15) Dandy, W. Benign tumors in the third ventricle of the brain: diagnosis and treatment. Thomas, Springfield, 1933, 171 pp. 16) Dandy, W. Operative experience in cases of pineal tumor. Arch. Surgery. 1936: **33**, 19–46. 17) Echols, D. H. Spongioblastoma polare. A clinicopathologic study of twelve cases. Arch. Neurol. and Psych. 1938: **39**, 494–512. 18) Eisenhardt, L. Long postoperative survivals in cases of intracranial tumor. Proc. Assoc. Research. Nerv. and Ment. Disease. 1935: **16**, 390–416. 19) Elsberg, C. A., Gotten, N. Results of conservative compared with radical operations in cerebellar medulloblastomas: analysis of twenty-three cases. Bull. Neurol. Inst. N. Y. 1933: **3**, 33–52. 20) Elvidge, O., Penfield, W. and Cone, W. The gliomas of the central nervous system. Proc. Assoc. Research. Nerv. and Ment. Disease. 1937: **16**, 107–179. 21) Fincher, E. F. and Coon, G. P. Ependymomas. Arch. Neurol. and Psych. 1929: **22**, 19–44. 22) Ford, F. R. Diseases of nervous system in infancy, childhood and adolescence. Thomas, Springfield. 1937: chap. VIII, pp. 674–723. 23) Frazier, C. H. Brain tumors in children. Arch. Pediat. 1936: **53**, 295–317. 24) Frazier C. H. and Alpers, B. J. Adamantinoma of the craniopharyngeal duct. Arch. Neur. and Psych. 1931: **26**, 905–965. 25) Ley, A. Contribución al estudio de los tumores intracraneales de origen mesenquimatoso, con aportación de dos casos de firoblastoma de los hemisférios cerebrales en niños menores de cinco años. Revista de cirurgia de Barcelona. 1935: **9**, 1–30. 26) McLean, A. J. Die Craniopharyngealtaschentumoren. Ztsch. f. d. ges. Neurol. & Psych. 1930: **126**, 639–682. 27) Oldberg, E. and Eisenhardt, L. The neurological diagnosis of tumors of the third ventricle. Arch. Neurol. & Psych, 1938, (in press). 28) Sachs, E. The Diagnosis and Treatment of Brain Tumors. Mosby, St. Louis, 1931, 396 pp. 29) Sachs, E. The radical versus the more conservative attitude in the treatment of brain tumors. Surg. Gyn. and Obst. 1937: **65**, 253–256. 30) Tönnis, W. and Zülch, K. J. Das Ependymom der Grosshirnhemisphären. Zentralbl. f. Neurochir. 1937: **2**, 141–164. 31) Turner. O. A. and Gardner, W. J. Familial involvement of the nervous system by multiple tumors of the sheaths and enveloping membranes. Am. Jour. Cancer, 1938: **32**, 339–360. 32) Vincent, Cl., David, M. and Puech, P. Traitement chirurgical des craniopharyngiomes. Comp. rendus VII^{e} congrès des pédiatres de langue française. Strasbourg, Oct. 5, 1931, pp. 1–17. 33) Vincent, Cl., Rappoport, and Randinesco. Résultats éloignés des interventions pour tumeurs du cerveau chez l'enfant. Bull. Soc. de Pédiatrie de Paris. 1934: **32**, 263–281. 34) Wagenen, W. P. van. Verified brain tumors: end results of 149 cases eight years after operation. J. Am. Med. Assoc. 1934: **102**, 1454–1458.